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C E R T I F I C A T E

I, Koichiro OHKURA, a member of MAEDA & NISHIDE of Kiriyaama Bldg., 1-1, Sarugaku-cho 2-chome, Chiyoda-ku, Tokyo, Japan hereby declare that I am conversant with the Japanese and the English languages and that I am the translator of the document attached and certify that to the best of my knowledge and belief the following is a true and correct English translation of the specification of Japanese Patent Application No. 10-347265 in the name of Nippon Zeon co., Ltd..

Signed this 10 day of March 2004

Koichiro Ohkura  
Koichiro OHKURA

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[DOCUMENT NAME] Specification

[TITLE OF THE INVENTION] Light Guide Plate

[CLAIMS]

[Claim 1] A light guide plate characterized by being  
5 obtained by performing melt molding a thermoplastic resin  
having a melt flow rate of at least 50 [g/10min.] measured  
based on JIS-K-6719 under a load of 2.16 kgf at 280°C.

[Claim 2] The light guide plate as set forth in claim  
1, wherein said thermoplastic resin has a 50% breaking energy  
10 of at least 0.01J in a drop-weight test, measured based on  
JIS-K-7211 for a 3 mm thick plate of the same using a  
missile-type weight of a radius of 3/4 inch.

[Claim 3] The light guide plate as set forth in claim  
1 or 2, wherein said thermoplastic resin is a thermoplastic  
15 resin containing an alicyclic structure.

[Claim 4] The light guide plate as set forth in claim  
3, wherein said thermoplastic resin containing an alicyclic  
structure is a norbornene-based polymer.

[Claim 5] A process of production of a light guide  
20 plate characterized by performing melt molding a  
thermoplastic resin having a melt flow rate of at least 50  
[g/10min.] under a load of 2.16 kgf at 280°C.

[Claim 6] The process of production of a light guide  
plate as set forth in claim 5, wherein said melt molding is  
25 injection molding.

## [DETAILED DESCRIPTION OF THE INVENTION]

[0001]

[Technical Field of the Invention]

The present invention relates to a light guide plate  
5 and the production method, more particularly to a light guide  
plate with an excellent appearance and reduced irregularity  
in luminance, in particular a thin-walled, large screen size  
light guide plate and the production method.

[0002]

10 [Prior Art]

A light guide plate is one of optical members used in  
a backlight unit mounted in various display devices. For  
example, an edge light type planar light source device is  
generally comprised of a light guide plate for guiding light  
15 from a light source entering from a side end face in a direction  
parallel to the plate face and causing it to be emitted, a  
reflector arranged so as to surround the light source for  
efficiently guiding the light of the light source not directly  
entering the light source-side end face of the light guide  
20 plate to the guide light plate, a light diffusion sheet  
arranged at the light emitting face side of the light guide  
plate for causing diffusion of light emitted from the emission  
face, and a reflection sheet arranged at the light reflection  
face side of the light guide plate for returning the light  
25 leaked from the light guide plate to the light guide plate

once again.

[0003]

Note that the back face of the light guide plate (light reflection face) is formed with a pattern of various shapes such as dots, cone cuts, and V-grooves for raising or  
5 uniformly diffusing the luminance of the light introduced into the light guide plate.

[0004]

The light guide plate has to have reduced irregularity  
10 in luminance since the entire emission face serves as the direct light source of various types of display devices. Further, it is believed desirable that the color temperature be high. Therefore, in the past, use has been made of a light guide plate made by injection molding a colorless transparent  
15 thermoplastic resin such as polymethyl methacrylate (PMMA) or polycarbonate (PC). Further, recent light guide plates have tended to be made thinner from the viewpoint of increasing the screen size or economizing the space.

[0005]

20 [Problems to be Solved by the Invention]

The PMMA normally used for molding a light guide plate, however, has a high melt viscosity at the time of injection molding and inferior fluidity and is difficult to mold into a thin-walled, large screen size of over 10 inches, further  
25 over 14 inches. Even if able to be molded, since it is thin,

there was the problem that hygroscopic deformation ended up occurring. On the other hand, if the resin temperature is raised to improve the fluidity, the resin is liable to foam in the cylinder and a shaped article with a good appearance is difficult to obtain such as due to the occurrence of voids. Further, since PC has a high heat deformation temperature, the molding temperature has to be raised in order to obtain fluidity sufficient for molding thin articles. As a result, due to the effects of moisture absorption, the resin is liable to hydrolyze and foam in the cylinder. In the same way as the case of PMMA, voids occurred in the shaped article (light guide plate) and it was difficult to obtain a shaped article with a good appearance. Therefore, a molding material has been sought which enables molding of a thin-walled light guide plate of a large screen size of over 10 inches or over 14 inches with a good appearance by injection molding.

[0006]

Further, when using PMMA or PC as the molding material and forming V-grooves etc. in the back face of the light guide plate, there has been the problem that it was not possible to precisely transfer the pattern of the fine shapes to the light reflection face side of the thinnest part, that is, the narrow end portion, in a wedge-shaped light guide plate where the thickness of the light guide plate becomes gradually thinner the further from the light source. This becomes a

cause of a reduction of the homogeneity of the light emitted due to luminance unevenness.

[0007]

The present invention was made in consideration of the  
5 above circumstances and has as its object thereof to provide a light guide plate of a good appearance and reduced irregularity in luminance, in particular a thin-walled, large screen size light guide plate, and a process for production of the same.

10 [0008]

[Means for Solving the Problem]

The present inventors took note of the melt fluidity of a thermoplastic resin and engaged in intensive studies with the aim of improving it. As a result, they discovered that  
15 by performing melt molding a thermoplastic resin having a specific melt flow rate (hereinafter also referred to as an "MFR"), it is possible to obtain a light guide plate with a good appearance and reduced irregularity in luminance, in particular a thin-walled, large screen size light guide plate,  
20 and thereby completed the present invention. Namely,

(1) A light guide plate according to the present invention is characterized by being obtained by performing melt molding a thermoplastic resin having a melt flow rate of at least 50 [g/10min.], preferably 50 to 250 [g/10min.],  
25 more preferably 60 to 180 [g/10min.] under a load of 2.16 kgf

at 280°C measured based on JIS-K-6719.

[0009]

A process of production of a light guide plate according to the present invention is characterized by performing melt  
5 molding a thermoplastic resin having a melt flow rate of at least 50 [g/10min.], preferably 50 to 250 [g/10min.], more preferably 60 to 180 [g/10min.] under a load of 2.16 kgf at 280°C measured based on JIS-K-6719.

[0010]

10 The melt molding is preferably injection molding.

[0011]

(2) Preferably, the thermoplastic resin has a 50% breaking energy of at least 0.01J, preferably at least 0.05J in a drop-weight test, measured based on JIS-K-7211 for a 3  
15 mm thick plate of the same using a missile-type weight of a radius of 3/4 inch.

(3) As the thermoplastic resin, a thermoplastic resin containing an alicyclic structure is preferable, and a norbornene-based polymer is preferable.

20 [0012]

The glass transition temperature (T<sub>g</sub>) of the thermoplastic resin is normally 70°C or more, preferably 70°C to 250°C, and more preferably 80°C to 200°C.

[0013]

25 The refractive index measured at 25°C based on

ASTM-D542 may be suitably selected in accordance with a use object, but is normally 1.40 to 1.70, preferably 1.50 to 1.60, more preferably 1.52 to 1.56.

[0014]

5 [Embodiment of the Invention]

Below, embodiments of the present invention will be explained.

[0015]

Thermoplastic Resin

10 As the thermoplastic resin used in the present invention, a thermoplastic resin having a specific MFR is used. Specifically, the MFR of the thermoplastic resin is at least 50 [g/10min.], preferably 50 to 250 g/min, more preferably 60 to 180 [g/10min.]. When the MFR of the thermoplastic resin  
15 is excessively low, the moldability is poor, so this is not preferable. Further, when conversely it is excessively high, the mechanical strength is inferior, a thin-walled, large screen size light guide plate is hard to produce, and the moldability is inferior such as with occurrence of burrs. A  
20 thermoplastic resin having the MFR of at least 50 [g/10min.] has low melting viscosity, so that melting fluidity of the resin at the time of melt molding can be improved and a shaped article (light guide plate) having good appearance can be  
25 viscosity at the time of molding a thin light guide plate with

a wide screen, fluidity and plasticity can be obtained even at a low temperature and cooling and curing become easy, as well. Furthermore, due to the preferable melt fluidity, accurate transfer can be realized when transferring a pattern of fine shapes, such as V-grooves on the reflection face of the light guide plate. Also, there are effects that cycle time at the time of molding can be relatively short and occurrence rate of voids, burn marks and discoloration is reduced. Accordingly, when producing a thin and wide screen sized (for example 14 inches or more) light guide plate, it becomes easy to produce those having good appearance and reduced luminance unevenness.

[0016]

The thermoplastic resin used in the present invention is not particularly limited as to its 50% breaking energy in a drop-weight test measured based on JIS-K-7211 for a 3 mm thick plate of the same using a missile-type weight of a radius of 3/4 inch, but is normally at least 0.01J, preferably at least 0.05J. The mechanical strength of the light guide plate obtained at the time of this range is suitably held even if the light guide plate is thin and has a large screen size. Further, it is resistant to occurrence of cracks or fractures and can be easily assembled into backlight units.

[0017]

The glass transition temperature ( $T_g$ ) of the



thermoplastic resin used in the present invention may be suitably selected in accordance with the object of use, but a higher one is preferable from the environment of use of the light guide plate. Normally, it is at least 70°C, preferably 70 to 250°C, more preferably 80 to 200°C. In this range, the properties of the heat resistance and moldability are well balanced.

[0018]

The refractive index at 25°C measured based on ASTM-D542 of the thermoplastic resin used in the present invention may be suitably selected in accordance with the object of use, but is normally 1.40 to 1.70, preferably 1.50 to 1.60, more preferably 1.52 to 1.56. The optical characteristics are desirable in this range.

[0019]

As the thermoplastic resin used in the present invention, for example, polymethyl methacrylate (PMMA), polyethyl methacrylate (PEMA), poly-n-propyl methacrylate (Poly(nPMA)), poly-n-butyl methacrylate (Poly(nBMA)), poly-n-hexyl methacrylate (Poly(nHMA)), polyisopropyl methacrylate (Poly(iPMA)), polyisobutyl methacrylate (Poly(iBMA)), poly-t-butyl methacrylate (Poly(tBMA)), polybenzyl methacrylate (PBzMA), polyphenyl methacrylate (PPhMA), poly-1-phenylethyl methacrylate (Poly(1-PhEMA)), poly-2-phenylethyl methacrylate

(Poly(2-PhEMA)), polyfurfuryl methacrylate (PFFMA),  
 polymethyl acrylate (PMA), polyethyl acrylate (PEA),  
 poly-n-butyl acrylate (Poly(nBA)), polybenzyl acrylate  
 (PBzMA), poly-2-chlorethyl acrylate (Poly(2-CiEA)),  
 5 polyvinyl acetate (PVAc), polyvinyl benzoate (PVB),  
 polyvinylphenyl acetate (VPhAc), polyacrylonitrile (PAN),  
 poly- $\alpha$ -methylacrylonitrile (Poly( $\alpha$ MAN)),  
 polymethyl- $\alpha$ -chloracrylate (PMA(2Cl)), poly-o-chlorostyrene  
 (Poly(o-ClSt)), poly-p-fluorostyrene (Poly(p-FSt)),  
 10 poly-p-isopropylstyrene (Poly(p-iPSt)), polystyrene (PSt),  
 polycarbonate (PC), thermoplastic resin containing an  
 alicyclic structure, etc. may be mentioned.

[0020]

Among the above thermoplastic resins, to mold a  
 15 thin-walled, large screen size light guide plate, a  
 thermoplastic resin containing an alicyclic structure is  
 preferred. The heat decomposition temperature of a  
 thermoplastic resin containing an alicyclic structure is high,  
 so by using such a resin, the moldability is further improved.  
 20 In particular, it becomes possible to mold without heat  
 decomposition or hydrolysis even at a high temperature. A  
 light guide plate with a good appearance can therefore be  
 obtained. Further, since the melt fluidity is improved, there  
 is less of a liability of transfer defects arising even when  
 25 forming a pattern of fine shapes such as V-grooves in the

reflection face of the light guide plate. Further, even when producing a thin-walled, large screen size light guide plate having heat resistance, having grooves as a pattern of fine shapes, it is possible to obtain a light guide plate reduced  
5 irregularity in luminance. Further, a thermoplastic resin containing an alicyclic structure is superior in transparency or heat resistance, so can be further improved in luminance. Accordingly, even if the light guide plate is used for a long time, there is less liability of occurrence of deformation  
10 due to changes in temperature. This makes it suitable for application as a light guide plate.

[0021]

The thermoplastic resin containing an alicyclic structure has alicyclic structures at its main chain and/or  
15 side chains. From the viewpoint of the mechanical strength, heat resistance, etc., one containing alicyclic structures at its main chain is preferable.

[0022]

As the alicyclic structures of the polymer, saturated  
20 cyclic hydrocarbon (cycloalkane) structures, unsaturated cyclic hydrocarbon (cycloalkene) structures, etc. may be mentioned, but from the viewpoint of mechanical strength and heat resistance, cycloalkane structures or cycloalkene structures are preferable. In particular, a thermoplastic  
25 resin having cycloalkane structures is most preferable.

[0023]

The number of carbon atoms making up the alicyclic structures is not particularly limited, but is usually 4 to 30, preferably 5 to 20, more preferably 5 to 15. In this range, the properties of the mechanical strength, heat resistance, and moldability are well balanced.

[0024]

The ratio of the monomers (a) giving repeating units of alicyclic structures in the thermoplastic resin containing an alicyclic structure used in the present invention may be suitably selected in accordance with the object of use, but normally is at least 40 mol%, preferably at least 50 mol%. If the ratio of monomers giving repeating units of alicyclic structures in the thermoplastic resin containing an alicyclic structure is excessively small, the heat resistance is inferior. By making the range from 40 to 100 mol%, the transparency, mechanical strength, heat resistance, etc. are well balanced.

[0025]

The balance of the thermoplastic resin containing an alicyclic structure other than the repeating units having the alicyclic structure is not particularly limited and may be suitably selected in accordance with the object of use.

[0026]

As specific examples of such a thermoplastic resin

containing an alicyclic structure, for example, (1) norbornene-based polymers, (2) monocyclic cyclic olefin-based polymers, (3) cyclic conjugated diene-based polymers, (4) vinyl alicyclic hydrocarbon-based polymers, etc. may be mentioned. Among these, norbornene-based polymers and cyclic conjugated diene-based polymers are preferable, while norbornene-based polymers are more preferable. When a norbornene-based polymer is used, the stability of appearance of the obtained light guide plate becomes much more remarkable, the occurrence of luminance unevenness is greatly reduced, and a high mechanical strength is imparted to the light guide plate. Therefore, even if molding a thin-walled light guide plate with a large screen size, the new effect is obtained that cracks or fractures are difficult to occur and assembly into a backlight unit becomes easy.

[0027]

#### (1) Norbornene-Based Polymers

The norbornene-based polymers are not particularly limited, but for example the polymers disclosed in Japanese Unexamined Patent Publication (Kokai) No. 2-173112, Japanese Unexamined Patent Publication (Kokai) No. 5-9223, etc., specifically, addition type (co)polymers of norbornene-based monomers, addition-type copolymers of norbornene-based monomers and vinyl-based compounds, etc. may be mentioned.

25

[0028]

- As the norbornene-based monomers (a), for example,
- bicyclo[2,2,1]hept-2-ene (commonly called "norbornene"),
- 5-methyl-bicyclo[2,2,1]hept-2-ene,
- 5,5-dimethyl-bicyclo[2,2,1]hept-2-ene,
- 5 5-ethyl-bicyclo[2,2,1]hept-2-ene,
- 5-butyl-bicyclo[2,2,1]hept-2-ene,
- 5-ethylidene-bicyclo[2,2,1]hept-2-ene,
- 5-hexyl-bicyclo[2,2,1]hept-2-ene,
- 5-octyl-bicyclo[2,2,1]hept-2-ene,
- 10 5-octadecyl-bicyclo[2,2,1]hept-2-ene,
- 5-ethylidene-bicyclo[2,2,1]hept-2-ene,
- 5-methylidene-bicyclo[2,2,1]hept-2-ene,
- 5-vinyl-bicyclo[2,2,1]hept-2-ene,
- 5-propenyl-bicyclo[2,2,1]hept-2-ene,
- 15 5-methoxycarbonyl-bicyclo[2,2,1]hept-2-ene,
- 5-cyano-bicyclo[2,2,1]hept-2-ene,
- 5-methyl-5-methoxycarbonyl-bicyclo[2,2,1]hept-2-ene;
- 5-methoxycarbonyl bicyclo[2,2,1]hept-2-ene,
- 5-ethoxycarbonyl bicyclo[2,2,1]hept-2-ene,
- 20 5-methyl-5-methoxycarbonyl bicyclo[2,2,1]hept-2-ene,
- 5-methyl-5-ethoxycarbonyl bicyclo[2,2,1]hept-2-ene,
- bicyclo[2,2,1]hept-5-enyl-2-methylpropionate,
- bicyclo[2,2,1]hept-5-enyl-2-methyloctanate,
- bicyclo[2,2,1]hept-2-ene-5,6-dicarboxylic acid anhydride,
- 25 5-hydroxymethyl bicyclo[2,2,1]hept-2-ene,

- 5,6-di(hydroxymethyl) bicyclo[2,2,1]hept-2-ene,  
 5-hydroxy-i-propylbicyclo[2,2,1]hept-2-ene, 5,6-dicarboxy  
 bicyclo[2,2,1]hept-2-ene; 5-cyanobicyclo[2,2,1]hept-2-ene,  
 bicyclo[2,2,1]hept-2-ene-5,6-dicarboxylic acid imide;
- 5        tricyclo[4,3,0,1<sup>2,5</sup>]deca-3,7-diene (commonly called  
 "dicyclopentadiene"), tricyclo[4,3,0,1<sup>2,5</sup>]deca-3-ene;  
 tricyclo[4,4,0,1<sup>2,5</sup>]undeca-3,7-diene or  
 tricyclo[4,4,0,1<sup>2,5</sup>]undeca-3,8-diene or their partial  
 hydrogenates (or adducts of cyclopentadiene and cyclohexene)
- 10       tricyclo[4,4,0,1<sup>2,5</sup>]undeca-3-ene;  
 5-cyclopentyl-bicyclo[2,2,1]hept-2-ene,  
 5-cyclohexyl-bicyclo[2,2,1]hept-2-ene,  
 5-cyclohexenyl-bicyclo[2,2,1]hept-2-ene,  
 5-phenyl-bicyclo[2,2,1]hept-2-ene;
- 15       tetracyclo[4,4,0,1<sup>2,5</sup>,1<sup>7,10</sup>]-dodeca-3-ene (also simply  
 called tetracyclododecene),  
 8-methyltetracyclo[4,4,0,1<sup>2,5</sup>,1<sup>7,10</sup>]-dodeca-3-ene,  
 8-ethyltetracyclo[4,4,0,1<sup>2,5</sup>,1<sup>7,10</sup>]-dodeca-3-ene,  
 8-methylidenetetracyclo[4,4,0,1<sup>2,5</sup>,1<sup>7,10</sup>]-dodeca-3-ene,  
 20       8-ethylidenetetracyclo[4,4,0,1<sup>2,5</sup>,1<sup>7,10</sup>]-dodeca-3-ene,  
 8-vinyltetracyclo[4,4,0,1<sup>2,5</sup>,1<sup>7,10</sup>]-dodeca-3-ene,  
 8-propenyl-tetracyclo[4,4,0,1<sup>2,5</sup>,1<sup>7,10</sup>]-dodeca-3-ene,  
 8-methoxycarbonyltetracyclo[4,4,0,1<sup>2,5</sup>,1<sup>7,10</sup>]-dodeca-3-ene,  
 8-methyl-8-methoxycarbonyltetracyclo[4,4,0,1<sup>2,5</sup>,1<sup>7,10</sup>]-dode  
 25       ca-3-ene, 8-hydroxymethyltetracyclo

[4,4,0,1<sup>2,5</sup>,1<sup>7,10</sup>]-dodeca-3-ene, 8-carboxytetracyclo

[4,4,0,1<sup>2,5</sup>,1<sup>7,10</sup>]-dodeca-3-ene;

8-cyclopentyl-tetracyclo[4,4,0,1<sup>2,5</sup>,1<sup>7,10</sup>]-dodeca-3-ene,

8-cyclohexyl-tetracyclo[4,4,0,1<sup>2,5</sup>,1<sup>7,10</sup>]-dodeca-3-ene,

5 8-cyclohexenyl-tetracyclo[4,4,0,1<sup>2,5</sup>,1<sup>7,10</sup>]-dodeca-3-ene,

8-phenyl-cyclopentyl-tetracyclo[4,4,0,1<sup>2,5</sup>,1<sup>7,10</sup>]-dodeca-3-ene;

tetracyclo[7,4,0,1<sup>10,13</sup>,0<sup>2,7</sup>]trideca-2,4,6,11-tetraen

e (also called "1,4-methane-1,4,4a,9a-tetrahydrofluorene"),

10 tetracyclo[8,4,0,1<sup>11,14</sup>,0<sup>3,8</sup>]-tetradeca-3,5,7,12-tetraene

(also called

"1,4-methane-1,4,4a,5,10,10a-hexahydroanthracene"),

pentacyclo-[6,5,1,1<sup>3,6</sup>,0<sup>2,7</sup>,0<sup>9,13</sup>]pentadeca-3,10-diene,

pentacyclo[7,4,0,1<sup>3,6</sup>,1<sup>10,13</sup>,0<sup>2,7</sup>]pentadeca-4,11-diene;

15 tetramers of cyclopentadiene; and other norbornene-based monomers etc. may be mentioned. These norbornene-based monomers may be used alone or in combinations of two or more types.

[0029]

20 As the vinyl-based compounds able to be copolymerized (b), in particular chain-like vinyl compounds are suitable in increasing the heat resistance or transparency.

Specifically, ethylene, propylene, 1-butene, 1-pentene,

1-hexene, 3-methyl-1-butene, 3-methyl-1-pentene,

25 3-ethyl-1-pentene, 4-methyl-1-pentene, 4-methyl-1-hexene,



4,4-dimethyl-1-hexene, 4,4-dimethyl-1-pentene,  
4-ethyl-1-hexene, 3-ethyl-1-hexene, 1-octene, 1-decene,  
1-dodecene, 1-tetradecene, 1-hexadecene, 1-octadecene,  
1-eicocene, and other C<sub>2</sub> to C<sub>20</sub> ethylene or  $\alpha$ -olefin;

5           1,4-hexadiene, 4-methyl-1,4-hexadiene,  
5-methyl-1,4-hexadiene, 1,7-octadiene, and other  
nonconjugated dienes; etc. may be mentioned.

These vinyl-based compounds may be used alone or in  
combinations of two or more types.

10           [0030]

The ratio of the norbornene-based monomer (a) and the  
vinyl compound (b) may be suitably selected in accordance with  
the object of use, but the molar ratio (a/b) is usually 40/60  
to 100/0, preferably 50/50 to 100/0. When this, the mechanical  
15 strength, heat resistance, and transparency of the light  
guide plate are well balanced.

[0031]

Norbornene-based polymer may be obtained by the method  
of, for example, (co)polymerizing the monomer ingredients at  
20 a polymerization temperature of usually -50 to 100°C and a  
polymerization pressure of 0 to 50 kg/cm<sup>2</sup> in a solvent or not  
in a solvent in the presence of a catalyst system comprised  
of a titanium, zirconium, or vanadium compound and  
organoaluminum compound.

25           [0032]

## (2) Monocyclic Cyclic Olefin-Based Polymers

As the monocyclic cyclic olefin-based polymers, for example, use may be made of addition polymers of cyclohexene, cycloheptene, cyclooctene, and other monocyclic cyclic  
5 olefin-based monomers disclosed in Japanese Unexamined Patent Publication (Kokai) No. 64-66216.

[0033]

## (3) Cyclic Conjugated Diene-Based Polymers

As the cyclic conjugated diene-based polymers, for example,  
10 use may be made of polymers obtained by 1,2- or 1,4-addition polymerization of cyclopentadiene, cyclohexadiene, and other cyclic conjugated diene-based monomers and their hydrogenates disclosed at Japanese Unexamined Patent  
Publication (Kokai) No. 6-136057 or Japanese Unexamined  
15 Patent Publication (Kokai) No. 7-258318.

[0034]

## (4) Vinyl Alicyclic Hydrocarbon-Based Polymers

As the vinyl alicyclic hydrocarbon-based polymers, for example, polymers of vinyl cyclohexene, vinyl cyclohexane,  
20 and other vinyl alicyclic hydrocarbon-based monomers and their hydrogenates disclosed in Japanese Unexamined Patent  
Publication (Kokai) No. 51-59989, hydrogenates of aromatic ring portions of polymers of vinyl aromatic monomers such as styrene and  $\alpha$ -methylstyrene disclosed in Japanese Unexamined  
25 Patent Publication (Kokai) No. 63-43910, Japanese Unexamined

Patent Publication (Kokai) No. 64-1706, etc. may be used.

[0035]

Note that these thermoplastic resins including an alicyclic structure may be used alone or in combinations of two or more types.

[0036]

#### Other Ingredients

The thermoplastic resin for molding the "light guide plate" according to the present invention may, as needed, include a soft polymer and various types of compounding agents alone or in mixtures of two or more types.

[0037]

#### (1) Soft Polymers

In the present invention, the soft polymer to be blended into the thermoplastic resin usually means a polymer having a glass transition temperature ( $T_g$ ) of not more than  $30^{\circ}\text{C}$ . In the case of a polymer having several  $T_g$ 's and a polymer having both of the  $T_g$  and melting point ( $T_m$ ), any polymer having a lowest  $T_g$  of not more than  $30^{\circ}\text{C}$  is included in such a soft polymer.

[0038]

As such a soft polymer, (a) an olefin-based soft polymer mainly comprised of ethylene, propylene, or another  $\alpha$ -olefin, (b) an isobutylene-based soft polymer mainly comprised of isobutylene, (c) a diene-based soft polymer mainly comprised of butadiene, isoprene, or another conjugated diene, (d) a

soft polymer having silicon-oxygen bonds as skeletons  
(organic polysiloxane), (e) soft polymers mainly comprised  
of  $\alpha,\beta$ -unsaturated acids and their derivatives, (f) soft  
polymers mainly comprised of unsaturated alcohols and amines  
5 or their acyl derivatives or acetal, (g) polymers of epoxy  
compounds, (h) fluorine-based rubber, (i) other soft polymers,  
etc. may be mentioned.

[0039]

As specific examples of these soft polymers, for  
10 example,

as (a), liquid polyethylene, atactic polypropylene,  
1-butene, 4-methyl-1-butene, 1-hexene, 1-octene, and  
1-decene and other homo polymers; ethylene- $\alpha$ -olefin  
copolymers, propylene- $\alpha$ -olefin copolymers,  
15 ethylene-propylene-diene copolymers (EPDM),  
ethylene-cyclic olefin copolymers,  
ethylene-propylene-styrene copolymers, and other copolymers  
may be mentioned.

[0040]

20 As (b), polyisobutylene, isobutylene-isoprene rubber,  
isobutylene-styrene copolymers, etc. may be mentioned.

[0041]

As (c), polybutadiene, polyisoprene, and other  
conjugated diene homo polymers; a butadiene-styrene random  
25 copolymer, isoprene-styrene random copolymer,

acrylonitrile-butadiene copolymer, a hydrogenate of an  
acrylonitrile-butadiene copolymer, an  
acrylonitrile-butadiene-styrene copolymer, and other random  
copolymers of conjugated dienes; a butadiene-styrene block  
5 copolymer, styrene-butadiene-styrene block copolymer,  
isoprene-styrene block copolymer, styrene-isoprene-styrene  
block copolymer, and other block copolymers of conjugated  
dienes and aromatic vinyl-based hydrocarbons and their  
hydrogenates may be mentioned.

10 [0042]

As (d), dimethyl polysiloxane, diphenyl polysiloxane,  
dihydroxy polysiloxane, and other silicone rubbers etc. may  
be mentioned.

[0043]

15 As (e), polybutyl acrylate, polybutyl methacrylate,  
polyhydroxyethyl methacrylate, polyacrylamide,  
polyacrylonitrile, and other acryl monomer homo polymers;  
butylacrylate-styrene copolymers, and other copolymers of  
acryl monomers and other monomers may be mentioned.

20 [0044]

As (f), polyvinyl alcohol, polyvinyl acetate,  
polyvinyl stearate, polyvinyl benzoate, polyvinyl maleate,  
and other (esterified) unsaturated alcohol homo polymers;  
vinyl acetate-styrene copolymers and other copolymers of  
25 (esterified) unsaturated alcohols and other monomers may be

mentioned.

[0045]

As (g), polyethylene oxide, polypropylene oxide, epichlorohydrin rubber, etc. may be mentioned.

5 [0046]

As (h), vinylidene fluoride based rubber, ethylene tetrafluoride-propylene rubber, etc. may be mentioned.

[0047]

As (i), natural rubber, polypeptide, protein, and the  
10 polyester-based thermoplastic elastomer, vinyl  
chloride-based thermoplastic elastomer, polyamide-based  
thermoplastic elastomer, etc. disclosed in Japanese  
Unexamined Patent Publication (Kokai) No. 8-73709, etc. may  
be mentioned. These soft polymers may have cross-linked  
15 structures or may have functional groups introduced by  
modification.

[0048]

These soft polymers may be used alone or in mixtures  
of two or more types. Further, the ratio may be suitably  
20 selected within the range not detracting from the object of  
the present invention.

[0049]

## (2) Compounding Agent

As specific examples of the above various compounding  
25 agents, the agents are not particularly limited so long as

they are ones generally used in the plastic industry. For example, an antioxidant, UV absorbent, photostabilizer, near infrared absorbent, dye, pigment, or other coloring agent, lubricant, softening agent, anti-static agent, fluorescent  
5 brightening agent, filler, or other compounding agent may be mentioned.

[0050]

As the antioxidant, a phenol-based antioxidant, phosphorus-based antioxidant, sulfur-based antioxidant, etc.  
10 may be mentioned. Among these, a phenol-based antioxidant is preferable. An alkyl-substituted phenol-based antioxidant is particularly preferable.

[0051]

As the phenol-based antioxidant, conventionally known  
15 ones may be used. For example,  
2-t-butyl-6-(3-t-butyl-2-hydroxy-5-methylbenzyl)-4-methyl phenylacrylate,  
2,4-di-t-amyl-6-(1-(3,5-di-t-amyl-2-hydroxyphenyl)ethyl)phenylacrylate, and other acrylate-based compounds described  
20 in Japanese Unexamined Patent Publication (Kokai) No. 63-179953 or Japanese Unexamined Patent Publication (Kokai) No. 1-168643;

octadecyl-3-(3,5-di-t-butyl-4-hydroxyphenyl)propionate, 2,2'-methylene-bis(4-methyl-6-t-butylphenol),  
25 1,1,3-tris(2-methyl-4-hydroxy-5-t-butylphenyl)butane,

1,3,5-trimethyl-2,4,6-tris(3,5-di-t-butyl-4-hydroxybenzyl)  
benzene,

tetrakis(methylene-3-(3',5'-di-t-butyl-4'-hydroxyphenylpropionate)methane [that is,

5 pentaerythrimethyl-tetrakis(3-(3,5-di-t-butyl-4-hydroxyphenylpropionate)], triethyleneglycol

bis(3-(3-t-butyl-4-hydroxy-5-methylphenyl)propionate),

and other alkyl-substituted phenol-based compounds;

6-(4-hydroxy-3,5-di-t-butylanilino)-2,4-bisooctylthio

10 o-1,3,5-triazine, 4-bisooctylthio-1,3,5-triazine,

2-octylthio-4,6-bis-(3,5-di-t-butyl-4-oxyanilino)-1,3,5-t

riazine, or other triazine base-containing phenol-based

compounds, etc. may be mentioned.

[0052]

15 The phosphorus-based antioxidant is not particularly limited so long as it is one which is usually used in the general plastics industry. For example, triphenylphosphate,

diphenylisodecyl-phosphate, phenyldiisodecylphosphate,

tris(nonylphenyl)phosphate, tris(dinonylphenyl)phosphate,

20 tris(2,4-di-t-butylphenyl)phosphate,

10-(3,5-di-t-butyl-4-hydroxybenzyl)-9,10-dihydro-9-oxa-10

-phosphaphenanthren-10-oxide, and other

monophosphate-based compounds;

4,4'-butylidene-bis(3-methyl-6-t-butylphenyl-di-tri

25 decylphosphate),



4,4'-isopropylidene-bis(phenyl-di-alkyl ( $C_{12}$  to  $C_{15}$ )  
phosphate), and other diphosphate-based compounds etc. may  
be mentioned. Among these, a monophosphate-based compound is  
preferable. Tris(nonylphenyl)phosphate,  
5 tris(dinonylphenyl)phosphate,  
tris(2,4-di-t-butylphenyl)phosphate, etc. are particularly  
preferred.

[0053]

As the sulfur-based antioxidant, for example, dilauryl  
10 3,3-thiodipropionate, dimyristyl 3,3'-thiodipropionate,  
distearyl 3,3-thiodipropionate, laurylstearyl  
3,3-thiodipropionate,  
pentaerythritol-tetrakis-( $\beta$ -lauryl-thio-propionate,  
3,9-bis(2-dodecylthioethyl)-2,4,8,10-tetraoxaspiro[5,5]un  
15 decane, etc. may be mentioned.

[0054]

These antioxidants may be used alone or in combinations  
of two or more types. The amount of the antioxidant blended  
is suitably selected within a range not detracting from the  
20 object of the present invention, but normally is 0.001 to 5  
parts by weight, preferably 0.01 to 1 part by weight with  
respect to 100 parts by weight of the thermoplastic polymer  
resin.

[0055]

25 As the UV absorbent, for example,

2-(2-hydroxy-5-methylphenyl)-2H-benzotriazole,  
 2-(3-*t*-butyl-2-hydroxy-5-methylphenyl)-5-chloro-2H-benzotriazole,  
 2-(3,5-di-*t*-butyl-2-hydroxyphenyl)-5-chloro-2H-benzotriazole,  
 5 2-(3,5-di-*t*-butyl-2-hydroxyphenyl)-2H-benzotriazole,  
 5-chloro-2-(3,5-di-*t*-butyl-2-hydroxyphenyl)-2H-benzotriazole,  
 2-(3,5-di-*t*-amyl-2-hydroxyphenyl)-2H-benzotriazole,  
 and other benzotriazole-based UV absorbents;

4-*t*-butylphenyl-2-hydroxybenzoate,  
 10 phenyl-2-hydroxybenzoate,  
 2,4-di-*t*-butylphenyl-3,5-di-*t*-butyl-4-hydroxybenzoate,  
 hexadecyl-3,5-di-*t*-butyl-4-hydroxybenzoate,  
 2-(2H-benzotriazol-2-yl)-4-methyl-6-(3,4,5,6-tetrahydrophthalimidylmethyl)phenol,  
 15 2-(2-hydroxy-5-*t*-octylphenyl)-2H-benzotriazole,  
 2-(2-hydroxy-4-octylphenyl)-2H-benzotriazole, and other  
 benzoate-based UV absorbents;

2,4-dihydroxybenzophenone,  
 2-hydroxy-4-methylbenzophenone,  
 20 2-hydroxy-4-methoxybenzophenone-5-sulfonate 3-hydrate,  
 2-hydroxy-4-octyloxybenzophenone,  
 4-dodecaloxy-2-hydroxybenzophenone,  
 4-benzyloxy-2-hydroxybenzophenone,  
 2,2',4,4'-tetrahydroxy-benzophenone,  
 25 2,2'-dihydroxy-4,4'-dimethoxybenzo-phenone, and other

benzophenone-based UV absorbents;

ethyl-2-cyano-3,3-diphenylacrylate,  
2'-ethylhexyl-2-cyano-3,3-diphenylacrylate, and other  
acrylate-based UV absorbents; nickel

5 [2,2'-thiobis(4-t-octylphenolate)]-2-ethylhexylamine, and  
other metal complex-based UV absorbents etc. may be  
mentioned.

[0056]

As photostabilizers, for example,

10 2,2,6,6-tetramethyl-4-piperidylbenzoate,  
bis(2,2,6,6-tetramethyl-4-piperidyl)sebacate,  
bis(1,2,2,6,6-pentamethyl-4-piperidyl)-2-(3,5-di-t-butyl-  
4-hydroxybenzyl)-2-n-butylmalonate,  
4-(3-(3,5-di-t-butyl-4-hydroxyphenyl)propionyloxy)-1-(2-(  
15 3-(3,5-di-t-butyl-4-hydroxyphenyl)propionyloxy)ethyl)-2,2  
,6,6-tetramethylpiperidine, and other hindered amine-based  
photostabilizers may be mentioned.

[0057]

As the near infrared absorbent, for example,

20 cyanine-based near infrared absorbents; pyrylium-based  
infrared absorbents; squalilium-based near infrared  
absorbents; croconium-based UV absorbents; azulenium-based  
near infrared absorbents; phthalocyanine-based near  
infrared absorbents; dithiol metal complex-based near  
25 infrared absorbents; naphthoquinone-based near infrared

absorbents; anthraquinone-based near infrared absorbents; indophenol-based near infrared absorbents; azi-based near infrared absorbents; etc. may be mentioned. Further, the commercially available near infrared absorbents SIR-103, 5 SIR-114, SIR-128, SIR-130, SIR-132, SIR-152, SIR-159, SIR-162 (all made by Mitsui Toatsu Dyes), Kayasorb IR-750, Kayasorb IRG-002, Kayasorb IRG-003, IR-820B, Kayasorb IRG-022, Kayasorb IRG-023, Kayasorb CY-2, Kayasorb CY-4, Kayasorb CY-9 (all made by Nippon Kayaku), etc. may be 10 mentioned.

[0058]

The dyes are not particularly limited so long as they are ones which uniformly disperse and dissolve in thermoplastic resins including an alicyclic structure, but 15 broad use is made of oil-soluble dyes (various CI solvent dyes) since they are superior in solubility with the thermoplastic hydrocarbon-based polymers used in the present invention. As specific examples of oil-soluble dyes, the various types of CI solvent dyes described in Color Index, 20 vol. 3 of the Society of Dyes and Colourists may be mentioned.

[0059]

As pigments, for example, Pigment Red 38 and other dianilide-based pigments; Pigment Red 48:2, Pigment Red 53, Pigment Red 57:1, and other azo lake-based pigments; Pigment 25 Red 144, Pigment Red 166, Pigment Red 220, Pigment Red 221,

Pigment Red 248, and other condensation azo-based pigments;  
Pigment Red 171, Pigment Red 175, Pigment Red 176, Pigment  
Red 185, Pigment Red 208, and other benzimidazolone-based  
pigments; Pigment Red 122 and other quinacridone-based  
5 pigments; Pigment Red 149, Pigment Red 178, Pigment Red 179,  
and other perillene-based pigments; and Pigment Red 177 and  
other anthraquinone-based pigments may be mentioned.

[0060]

When the light guide plate produced by the process of  
10 the present invention requires coloring, both a dye and  
pigment can be used within the range of the object of the  
present invention and are not limited, but coloring by a dye  
is preferable in the case of a light guide plate where  
microoptical characteristics become a problem. Further, a UV  
15 absorbent sometimes appears yellow to red to the eye, while  
a near infrared absorbent sometimes appears black to the eye.  
Therefore, there is no need for strictly differentiating  
between these and dyes in use. Further, they may be used  
together.

20 [0061]

As the lubricant, an ester of an aliphatic alcohol, an  
ester of a polyhydric alcohol, or a partial ester or other  
organic compound or inorganic particles etc. may be used. As  
organic compounds, for example, glyceryl monostearate,  
25 glyceryl monolaurate, glyceryl distearate, pentaerythritol

monostearate, pentaerythritol distearate, pentaerythritol  
tristearate, etc. may be mentioned.

[0062]

As other lubricants, generally it is possible to use  
5 inorganic particles. Here, as the inorganic particulates,  
particles of oxides, sulfides, hydroxides, nitrides, halides,  
carbonates, sulfates, acetates, phosphates, phosphites,  
organic carboxylates, silicates, titanates, and borates of  
elements of Group I, Group II, Group IV, and Groups VI to XIV  
10 of the Periodic Table and hydrous compounds or complex  
compounds, natural compounds, etc. of the same may be  
mentioned.

[0063]

As the plasticizer, for example, tricresyl phosphate,  
15 trixylyl phosphate, triphenyl phosphate, triethylphenyl  
phosphate, diphenylcresyl phosphate, monophenyldicresyl  
phosphate, diphenylmonoxylenyl phosphate,  
monophenyldixylenyl phosphate, tributyl phosphate, triethyl  
phosphate, and other phosphate triester-based plasticizers;  
20 dimethyl phthalate, dibutyl phthalate, diheptyl phthalate,  
di-n-octyl phthalate, di-2-ethylhexyl phthalate, diisononyl  
phthalate, octyldecyl phthalate, butylbenzyl phthalate, and  
other phthalate ester-based plasticizers; butyl oleate,  
glyceryl monooleate esters, and other fatty acid-basic acid  
25 ester-based plasticizers; divalent alcohol ester-based

plasticizers; oxylate ester-based plasticizers; etc. may be used. Among these, phosphate triester-based plasticizers are preferable. Tricresyl phosphate and trixylyl phosphate are particularly preferable.

5 [0064]

Further, as specific examples of the plasticizer, squalane ( $C_{30}H_{62}$ ,  $Mw = 422.8$ ), liquid paraffin (White Oil, ISO VG10, ISO VG15, ISO VG32, ISO VG68, ISO VG100, VG8, VG21, etc. defined in JIS K2231), polyisobutene, hydrated polybutadiene, 10 hydrated polyisoprene, etc. may be mentioned. Among these, squalane, liquid paraffin, and polyisobutene are preferred.

[0065]

As an anti-static agent, stearyl alcohol, behenyl alcohol, and other long-chain alkyl alcohols, glyceryl 15 monostearate, pentaerythritol monostearate, and other fatty acid esters of polyhydric alcohols etc. may be mentioned, but stearyl alcohol and behenyl alcohol are particularly preferable.

[0066]

20 These compounding agents may be used mixed in two types or more. The ratio may be suitably selected within a range not detracting from the object of the present invention. The amount blended may be suitably selected within a range not detracting from the object of the present invention, but is 25 normally in a range of 0.001 to 5 parts by weight, preferably

0.01 to 1 part by weight, with respect to 100 parts by weight of the thermoplastic polymer resin.

[0067]

#### Molding Material

5 In the present invention, it is possible to use the above thermoplastic resin alone or a thermoplastic resin plus, as needed, the above soft polymer or compounding agents as the molding material. The molding material is normally kneaded, then extruded into strands in the molten state using a  
10 twin-screw kneader and cut into suitable lengths by a strand cutter for pelletization.

[0068]

#### Light Guide Plate

The "light guide plate" in the present invention is a  
15 member for guiding light of a light source entering a side end face in the longitudinal direction and emitting it. It is not limited in application, but means a light guide plate which is used in planar light source devices used as backlights for laptop type, notebook type, book type, palmtop  
20 type, and other type PCs, word processors, and other office automation apparatuses, wall hanging and other liquid crystal televisions and other household electrical appliances, decorative electrical signboards, light tables, viewers, and other display devices.

25

[0069]



Next, an explanation will be given of an embodiment of a light guide plate according to the present invention. FIG. 1A is a perspective view showing the outline of a planar light source device including a light guide plate of the present embodiment; FIG. 1B is a sectional view of FIG. 1A; FIG. 1C is an enlarged view of principal parts of FIG. 1B; and FIG. 1D is a partially enlarged view of the reflection face of FIG. 1C. First, an explanation will be given of a planar light source device, in particular an edge light type planar light source device.

[0070]

The edge light type planar light source device 10 is, for example, as shown in FIG. 1(A), comprised of a light guide plate 100 for guiding and emitting light from a light source incident from a incidence face 100a in a longitudinal direction, a light source 200 comprised of a cold cathode tube etc. arranged at least at one side face of the light guide plate, a lamp reflector 300 arranged so as to surround the light source 200 for efficiently guiding to the light guide plate 100 the light of the light source which did not directly strike the light source side end face 100a of the light guide plate 100, a light diffusion sheet 400 arranged at the emission face 100b of the light guide plate 100 for diffusing the light emitted from the light reflection face 100c, and a reflection sheet 500 arranged at the reflection face 100c

side of the light guide plate 100 for returning the light leaking from the light guide plate 100 to the light guide plate 100 once again.

[0071]

5       As shown in FIG. 1(B), the light guide plate 100 according to the present embodiment forms a wedge shape so that the sectional shape becomes gradually thinner the further from the light source 200 so that light emitted from the emission face 100b becomes uniform as a whole. The further  
10   the sectional face is from the light source 200, the less the incident angle  $\theta_1$  (refer to FIG. 1(C)) with respect to an outside of the emission surface 100b of the light guide plate becomes than the critical angle (the minimum angle of bringing entire reflection). Note that the light guide plate in the  
15   present invention has a thickness of a face 100a based on the incidence face of not more than 5 mm, preferably 0.1 to 4 mm, more preferably 0.3 to 3 mm. A thickness of the opposed face 100d is not more than 4 mm, preferably 0.05 to 3 mm, more preferably 0.1 to 2 mm. Further, the ratio of area of the  
20   incidence face and the emission end face is, based on the former/latter, 1/5 to 1/500, preferably 1/10 to 1/400, more preferably 1/15 to 1/300. Further, greater effects can be expected in a light guide plate having a length of the diagonal of the emission face of 10 inches or more.

25

[0072]

As shown in FIG. 1(C), in this embodiment, a mold which can give a light guide plate having on the back face of the light guide plate 100 a pattern comprised of V-grooves 1001 in a gradually increasing density or deeper depth from the light source side of the light guide plate 100 to the end portion is used. The pitch  $P_c$  (see FIG. 1(D)) between adjoining V-grooves 1001 in the present embodiment is 10 to 5000  $\mu\text{m}$ , preferably 30 to 1000  $\mu\text{m}$ , more preferably 50 to 500  $\mu\text{m}$ . Further, the height  $H$  of the V-groove 1001 is 10 to 5000  $\mu\text{m}$ , preferably 30 to 1000  $\mu\text{m}$ , more preferably 50 to 500  $\mu\text{m}$ . Further, the pitch  $P_c$  at the end portion light reflection face 100d side of the light guide plate 100 between V-grooves 1001 is preferably 0.5 to 50% smaller than the pitch  $P_c$  at the incidence face 100a.

[0073]

#### Molding Method

As the method for molding the above light guide plate, it is sufficient to use a conventionally known molding method. For example, injection molding, press molding, extrusion blow molding, injection blow molding, multilayer blow molding, connection blow molding, double-wall blow molding, draw blowing, vacuum forming, rotational molding, and other molding methods may be mentioned, but the preferred method is melt molding (for example, hot press molding or injection molding). More preferable is injection molding from the

viewpoint of the moldability and productivity. Below, the explanation will be given taking as an example the case of producing a light guide plate by injection molding.

[0074]

5        Injection Molding

In the present embodiment, an explanation will be made of the process for production of the above light guide plate 100 by a screw type injection molding machine. FIG. 2 (A) to FIG. 2 (E) are schematic views showing a production method of a light guide plate according to the first embodiment of the present invention, FIG. 3 (A) is a sectional view of a light guide plate produced by the method in FIG. 2, and FIG. 3 (B) is a view form the bottom of FIG. 3 (A).

[0075]

15        The screw type injection molding machine, as shown in FIG. 2 (A), is comprised of a hopper 1, a heating cylinder 2, a screw 3, a mold 4, and an injection cylinder 5. Note that the process of molding of the present invention is not particularly limited so long as it is suitable for molding a thin-walled and a large screen size.

[0076]

(1)    Charging of Molding Material and Plasticizing and Melting of Same

First, as shown in FIG. 2 (A), a hopper 1 is charged with a molding material comprised of the above-mentioned

thermoplastic resin and other polymers, various compounding agents, and a filler mixed in in accordance with need all mixed in a predetermined ratio, kneaded by for example a twin-screw kneader, and pelletized. The charged molding material falls  
5 by its own weight in the heating cylinder 2 to contact the screw 3 and is gradually sent to the front end of the heating cylinder 2 by the rotation of the screw.

[0077]

Here, it is desirable to control the temperature of the  
10 heating cylinder 2. The melting temperature of the molding material differs depending on the type of the thermoplastic resin used, but normally is 150 to 400°C, preferably 180 to 360°C, more preferably 190 to 330°C, particularly preferably 200 to 300°C. Therefore, the temperature of the heating  
15 cylinder 2 is suitably determined so that the molding material melts well and the resin is not broken down by heat and exhibits a stable, high fluidity in the mold. By maintaining this temperature, it is possible to reduce burn marks of the resin or molding strain. The temperature of the heating cylinder  
20 2 may be controlled by a jacket or heater.

[0078]

The speed of the screw 3 is suitably determined so that the molding material is homogeneously mixed.

[0079]

25 (2) Accumulation of Molding Material and Retraction of

## Screw

The molding material plasticized and melted in this way is stocked in a predetermined amount at the front end of the screw 3. Along with the progress in the plasticization, the screw 3 is retracted by a predetermined distance so as to move away from the nozzle 21 at the front end of the heating cylinder 2 in the heating cylinder 2. At this time, it is preferably to apply a back pressure of 20 to 150 kgf/cm<sup>2</sup> at the injection cylinder side in a direction suppressing the retraction motion of the screw 3. By making the back pressure 20 to 150 kgf/cm<sup>2</sup>, it is possible to enhance the effect of plasticization and kneading of the molding material and possible to prevent the occurrence of bubbles and silver streaks of the molding material.

[0080]

By making the screw 3 retract a predetermined distance in the heating cylinder 2, a predetermined amount of molding material is stocked near the front end nozzle 21 of the cylinder 2 and made the amount of injection of the molding material injected in the mold 4. The amount of injection is not particularly limited due to the size, thickness, etc. of the light guide plate. The control of the retraction distance is suitably determined by a not shown microswitch etc.

[0081]

(3) Injection

Next, as shown in FIG. 2(B) and FIG. 2(C), the injection cylinder 5 is used to make the screw 3 advance at a predetermined speed toward the nozzle 21 of the heating cylinder 2 to make the plasticized and molten molding material stocked near the nozzle 21 pass through the nozzle 21 and fill the mold 4.

[0082]

At this time, the injection speed is preferably changed in three stages. That is, first, the screw 3 is made to advance toward the nozzle 21 at a predetermined speed  $V_1$  to push the molding material into the sprue and runner. When starting to pass near the gate of the mold, the speed of advance of the screw 3 is reduced to the speed  $V_2$ , then made a speed  $V_3$  faster than the speed  $V_1$  of the start of advance. This speed  $V_3$  corresponds to the injection speed. Specifically, the injection speed corresponding to the speed  $V_3$  of advance of the screw 3 is preferably made 10 to 1000  $\text{cm}^3/\text{s}$  in the present embodiment. If the injection speed is less than 10  $\text{cm}^3/\text{s}$ , it is difficult to obtain a thin-walled, large screen size light guide plate with a high planar accuracy. Luminance unevenness tends to easily occur. On the other hand, the upper limit of the injection speed is preferably determined within a range enabling control of the fluidity of the molding material, but if the injection speed is too fast, the temperature of the molding material rapidly rises due to the shearing force and

is liable to become a cause of silver streaks on the shaped article.

[0083]

Further, the pressure applied to the molding material  
5 when injecting the molding material from the nozzle 21  
(injection pressure) by making the screw 3 move forward to  
the nozzle 21 side may be suitably determined by mainly the  
viscosity characteristic (fluidity) of the molding material,  
the shape or thickness of the shaped article, or the structure  
10 of the mold 4. The injection pressure is divided into two  
stages: the stage of injection of the molding material in the  
mold 4 (hereinafter referred to as the "injection pressure")  
and the stage after the mold finishes being filled  
(hereinafter referred to as the "holding pressure"). The  
15 injection pressure gradually rises at the time of filling the  
molding material in the mold and then sharply rises and  
sharply falls reaching the peak pressure when the mold  
finishes being filled. The pressure applied inside the mold  
after that is the holding pressure.

20 [0084]

The holding pressure is the pressure applied for a  
certain time after the mold is substantially filled by the  
injection pressure until the gate portion of the mold 4  
completely cools and solidifies. The lower limit is at least  
25 100 kgf/cm<sup>2</sup>, preferably at least 120 kgf/cm<sup>2</sup>, more preferably



at least 150 kgf/cm<sup>2</sup>. By making the holding pressure at least 100 kgf/cm<sup>2</sup>, the occurrence of whiskers at the light guide plate as the shaped article is prevented, the mold shrinkage factor can be made small, and a light guide plate superior in dimensional accuracy can be obtained. On the other hand, the upper limit of the holding pressure is preferably determined within the range of the clamping pressure of the mold. If the holding pressure exceeds the clamping pressure of the mold, the mold is liable to open during the cooling. Therefore, the holding pressure is not more than 2000 kgf/cm<sup>2</sup>, preferably not more than 1500 kgf/cm<sup>2</sup>, more preferably not more than 1200 kgf/cm<sup>2</sup>.

[0085]

In the present embodiment, the peak pressure is 95 to 15% of the holding pressure, more preferably 90 to 40%, most preferably 80 to 60%. If set in this range, it is possible to prevent filling defects (short shots) in the mold and increase the density of the light guide plate of the shaped article and possible to keep the mold shrinkage factor low, so possible to obtain a high precision light guide plate. Further, it is possible to suppress the occurrence of excess burrs in the shaped article and prevent the occurrence of deformation occurring due to excessive internal stress remaining in the shaped article and possible to avoid difficulty of mold release due to over packing in the mold

4 and thereby prevent damage to the mold.

[0086]

The nozzle size of the injection molding machine is determined so that the molding material does not decompose by heat, but in the present embodiment if using a thermoplastic resin containing an alicyclic structure as a molding material, it is possible to set the nozzle size smaller than in the past.

[0087]

10 Note that, as shown in FIG. 3(A) and FIG. 3(B), in the present embodiment, injection molding is preferably performed so as to leave marks 600 corresponding to the gate on the light emission face 100b side close to the light incidence face side near the approximate center of the light guide plate 100. Also, a thickness of the gate is 50% or more of a thickness of a side face of the wedge shape having the gate. The area of the gate is, in terms of the ratio with the area of the side face of the wedge shape having the gate, 1:2 to 1:15, preferably 1:2.5 to 1:10, more preferably 1:3 to 1:5.

15 By injecting the molding material from this portion at this time, the fluid characteristics of the material in the mold are improved, flow marks and whiskers are prevented, no gate marks 600 remain at the light reflection face 100c of the light guide plate, and luminance unevenness is difficult to occur,

20 so gate cutting also become easy.

25

[0088]

(4) Cooling and Solidification of Molding Material

The molding material filled in the mold 4 is held for a certain time in the mold 4 for cooling and solidification.

5 [0089]

The mold temperature is not particularly limited, but is 10 to 180°C, preferably 40 to 150°C, more preferably 60 to 120°C. Generally, the lower the mold temperature, the more preferable in terms of molding efficiency for sooner  
10 completion of cooling and easy release of the shaped article from the mold (releasability), but when it is excessively low, fluidity of the resin in the mold becomes poor to cause molding defectives. On the other hand, in terms of moldability, the higher the mold temperature, the better for improving the  
15 fluidity of the molding material, but when it is too high and exceeds the glass transition point  $T_g$  of the molding material, releasability of the light guide plate as a shaped material from the mold becomes poor and highly accurate shaped article cannot be obtained. By setting the mold temperature at 10 to  
20 180°C, the molding efficiency and moldability can be balanced.

[0090]

The cooling time may be suitably changed according to the cylinder temperature, mold temperature, thickness of the  
25 shaped article, etc. If the cooling time is extended, it is

possible to reduce the deformation of the shaped article, but this ends up lengthening the cycle time and makes release of the shaped article from the mold difficult. On the other hand, if the cooling time is shortened, the solidification of the shaped article becomes insufficient and therefore deformation of the shaped article or deterioration of the dimensional stability ends up being caused. Therefore, it is necessary to determine the optimal cooling time taking into consideration these facts as well. Usually, it is about 1 to 15 minutes.

[0091]

Note that the clamping pressure of the mold is 2000 to 100 kgf/cm<sup>2</sup>, preferably 1900 to 500 kgf/cm<sup>2</sup>, and more preferably 1800 to 1000 kgf/cm<sup>2</sup>. By setting the clamping pressure of the mold to 2000 to 100 kgf/cm<sup>2</sup>, a disadvantage that the mold opens due to a pressure applied to the mold at the time of charging the molding material into the mold can be prevented, furthermore, it contributes to an improvement of the molding efficiency.

[0092]

#### (5) Extraction of Shaped Article

After cooling in the mold for a certain time in this way, the mold is opened and the shaped article (light guide plate 10) is removed, whereupon one cycle of the molding process is completed (see FIG. 2E). This cycle may be

performed by either manual operation or automatic operation.

### Examples

Below, the present invention will be described based on further specified examples by comparing with comparative  
5 examples, but the present invention is not limited to these examples. Further, in the examples and comparative examples of the invention below, the "parts" and "%" are based on weight unless specifically stated otherwise.

[0093]

10 The methods of measuring the various physical properties in the following Production Examples, Examples, and Comparative Example were as follows.

[0094]

(1) The refractive index is a value measured based on  
15 ASTM-D542 at 25°C.

[0095]

(2) The glass transition temperature (T<sub>g</sub>) is a value measured based on JIS-K7121.

[0096]

20 (3) The melt flow rate (MFR) was measured based on JIS-K6719 a load of 2.16 kgf at 280°C. The diameter of a hole of the die was 2.095±0.03 mm, while the distance of movement of the piston was made 25.0±0.25 mm.

[0097]

25 (4) The 50% breaking energy of the drop-weight test was

obtained by injection molding a 3 mm thick plate and measurement based on JIS-K-7211 in an atmosphere of a temperature of 23°C and a relative humidity of 50% dropping a missile-shaped weight of a radius of 3/4 inch on the plate.

5 [0098]

(5) The transparency was measured by measuring the light transmittance (%) while continuously changing the wavelength in a range of 400 to 900 nm by a spectrophotometer (Model U-30 made by Nippon Bunkosha) and defining the minimum  
10 transmittance as the light transmittance of the light guide plate. The higher the light transmittance, the better the transparency.

[0099]

(6) The appearance and moldability was determined by  
15 checking if there are bubbles, voids, or other defects in the light guide plate obtained by sight or checking if the shapes of the V-grooves have been transferred well and evaluated by the following judgment criteria:

[0100]

20 ◎: good transfer of shapes of V-grooves without defectives

○: No problem in molding in transfer of shapes of V-grooves

△: bubbles, voids, burrs, and other defects partially  
25 observed and gaps or short shots partially observed in

transfer of V-grooves

X: bubbles, voids, burrs, and other defects

observed and gaps or short shots observed in transfer of V-grooves

5 [0101]

(7) The luminance unevenness was obtained by measuring the luminance at three spots (vertical direction) at equal intervals at each of the thick part and thin part of the face of the light guide plate (rectangular face 1.5 cm inside from the periphery of the face of the light guide plate) using a  
10 luminance meter (BM-7, made by Topcon Co.), calculating the luminance unevenness (%) by (minimum value/maximum value) x 100, and evaluating the results by the following judgment criteria:

15 [0102]

◎: 88% or more

○: 85% to less than 88%

△: 82% to less than 85%

X: less than 82%

20 (8) The heat resistance was evaluated by measuring the dimensional changes due to changes in the environment (temperature changes). A light guide plate is normally lighted for a long time, so dimensional changes due to temperature often become problems. Therefore, the  
25 dimensional change after holding a light guide plate in a gear

oven at 100°C for 24 hours was measured as a representative characteristic and evaluated by the following judgment criteria:

[0103]

- 5       ⊙: no dimensional changes of 0.1% or less  
         ○: dimensional changes of over 0.1% to 0.3%  
         △: dimensional changes of over 0.3% to 1.0%  
         ×: dimensional changes of over 1.0%

(9) The mechanical strength was evaluated by the impact  
10 resistance by a drop test. A 3/4 inch radius missile-shaped  
weight (weight 10 g) was allowed to naturally drop from a  
height of 50 cm on the same positions of 10 prepared light  
guide plates. The occurrence of cracks or fractures was  
examined. The evaluation was conducted by the following  
15 judgment criteria:

[0104]

- ⊙: cracks or fractures in zero out of 10 samples  
         ○: cracks or fractures in one to three out of 10 samples  
         △: cracks or fractures in four to six out of 10 samples  
20       ×: cracks or fractures in seven or more out of 10  
samples

[Production Example 1]

Bicyclo[2,2,1]hept-2-ene (hereinafter referred to as  
"NB") (118 kg) was added to a reaction vessel charged with  
25 258 liters of cyclohexane at ordinary temperature in a flow



of nitrogen gas and agitated for 5 minutes.

Triisobutylaluminum was added to a concentration in the system of 1.0 ml/liter. Next, ethylene was circulated, with agitation, at ordinary pressure to make the system an ethylene atmosphere. The autoclave was held at an inside temperature of 70°C and pressurized by ethylene to an inside pressure of 6 kg/cm<sup>2</sup> by gauge pressure. This was agitated for 10 minutes, then 5.0 liters of a toluene solution containing isopropylidene(cyclopentadienyl)(indenyl)zirconium dichloride and methylalumoxan prepared in advance was added to the system so as to initiate the copolymerization reaction of ethylene and NB. The concentration of the catalyst at this time was 0.015 mmol/liter of isopropylidene(cyclopentadienyl)(indenyl)zirconium dichloride to the entire system. The concentration of methylalumoxane was 7.5 mmol/liter.

[0105]

During the polymerization, ethylene was continuously fed into the system to hold the temperature at 70°C and the internal pressure at 6 kg/cm<sup>2</sup> in gauge pressure. After 50 minutes, the polymerization reaction was stopped by addition of isopropyl alcohol. After the depressurization, the polymer solution was taken out, then brought into contact with an aqueous solution comprised of 1 m<sup>3</sup> of water plus 5 liters of concentrated hydrochloric acid in a 1:1 ratio under strong

agitation to cause the catalyst residue to move to the aqueous phase. The contact mixture was allowed to stand, then the aqueous phase was separated and removed and the remainder rinsed twice to purify and separate the polymerization  
5 solution phase.

[0106]

The reaction solution was passed through a guard filter, then removed of the solvent and monomer and other volatile components by direct drying using a centrifugal thin film  
10 continuous evaporation drier. The obtained molten resin was pelletized by a melt extruder to obtain a copolymer (A) of ethylene and NB.

[0107]

The weight average molecular weight  $M_w$  of the  
15 ethylene-NB copolymer (A) obtained in this way measured converted to polyisoprene by a GPC (gel permeation chromatograph) using cyclohexane as a solvent was 38000, the molecular weight distribution  $M_w/M_n$  was 2.37, the MFR of the polymer was 55 [g/10min.], the 50% breaking energy was 0.63J,  
20 the glass transition temperature  $T_g$  was 140°C, the refractive index was 1.53, and the NB content calculated by  $^{13}\text{C}$ -NMR was 53 mol%.

[0108]

[Production Example 2]

25 The same procedure was followed as in Production

Example 1 other than making the reaction time 46 minutes to obtain an ethylene-NB copolymer (B) having an MFR of 65 [g/10min.], a 50% breaking energy of 0.48J, a Tg of 141°C, a refractive index of 1.53, and an NB content of 53%.

5 [0109]

[Production Example 3]

The same procedure was followed as in Production Example 1 other than making the reaction time 20 minutes to obtain an ethylene-NB copolymer (C) having an MFR of 178  
10 [g/10min.], a 50% breaking energy of 0.31J, a Tg of 141°C, a refractive index of 1.53, and an NB content of 55%.

[0110]

[Production Example 4]

The same procedure was followed as in Production Example 1  
15 for polymerization other than adjusting the internal pressure by the ethylene to become a gauge pressure of 6.4 kg/cm<sup>2</sup>. The obtained ethylene-NB copolymer (D) had an MFR of 52 [g/10min.], a 50% breaking energy of 0.19J, a Tg of 123°C, a refractive index of 1.53, and an NB content of 43%.

20 [0111]

[Production Example 5]

The same procedure was followed as in Production Example 1 other than making the reaction time 17 minutes to obtain an ethylene-NB copolymer (E) having an MFR of 203  
25 [g/10min.], a 50% breaking energy of 0.10J, a Tg of 142°C,

a refractive index of 1.53, and an NB content of 53%.

[0112]

[Production Example 6]

The same procedure was followed as in Production  
5 Example 1 for polymerization other than adjusting the  
internal pressure by the ethylene to become a gauge pressure  
of 6.8 kg/cm<sup>2</sup>. The obtained ethylene-NB copolymer (F) had an  
MFR of 53 [g/10min.], a 50% breaking energy of 0.03J, a T<sub>g</sub>  
of 105°C, a refractive index of 1.53, and an NB content of  
10 33%.

[0113]

Examples 1 to 6

0.2 part by weight of the phenol-based antioxidant  
pentaerythrityl-tetrakis(3-(3,5-di-t-butyl-4-hydroxypheny  
15 1)propionate) and 0.4 part by weight of the hydrogenated  
styrene-butadiene-styrene block copolymer (Tuftec H1051  
made by Asahi Kasei, crumbs, refractive index of 1.52 at 30°C)  
were mixed in 100 parts by weight of each polymer obtained  
in Production Examples 1 to 6 and kneaded by a twin-screw  
20 kneader, then the strands (strand shaped molten resin) were  
passed through a strand cutter to obtain a pellet- (granular)  
shaped molded material. These pellets were injection molded  
to prepare light guide plates A to F. The molding conditions  
of the injection molding were the use of an injection molding  
25 machine of Model IS450 made by Toshiba Machinery, a mold

temperature of 60°C, a cylinder temperature of 310°C, a nozzle temperature of 260°C, an injection pressure of 1000 kgf/cm<sup>2</sup>, a holding pressure of 800 kgf/cm<sup>2</sup>, a mold clamping pressure of 1200 kgf/cm<sup>2</sup>, an injection speed (corresponding to screw speed of advance) of 40 cm<sup>3</sup>/s, a screw back pressure of 70 kgf/cm<sup>2</sup>, and a screw speed of 30 rpm. Further, the time from the start of filling into the mold to the end of filling was 1 second.

[0114]

10       The obtained light guide plate, as shown in FIG. 1(A) and FIG. 1(B), was a wedge shape having a thickness at wide end (100a side) of 2.4 mm, a thickness of the narrow end side (100d side) of 0.5 mm, a length from the wide end to the narrow end side of 180 mm, a length along the axial direction of the linear light source of 320 mm, that is, a 14.5 inches size, and a gradually decreasing thickness in the direction from the wide end side to the narrow end side (direction substantially perpendicular to the center axis of the linear light source). At the time of mold release, no short shots or burrs and no cracks in the shaped article were observed in the shaped articles of Examples 1 to 4 and 6 using the ethylene-NB copolymers (A) to (D) and (F). On the other hand, for Example 5 using the ethylene-NB copolymer (E), while the transfer of the V-grooves was good, since the reaction time at the time of production of the resin was short, some burrs

15

20

25

occurred.

[0115]

The light reflection face side of the light guide plate is formed with V-grooves becoming gradually denser the further from the wide end side of the light guide plate to the narrow end side. The V-groove had an apical angle of  $110^\circ$ , a pitch near the light source of 0.3 to 1.5 mm, and a pitch near the narrow end of 0.03 to 0.06 mm. The depth of the groove was made a uniform one of about 80  $\mu\text{m}$ . Further, the transferability of the V-grooves near the narrow end was good. The gate shown in FIG. 3 is positioned at the side close to the light incident face from the substantial center portion of the side of the light emission face. The gate length was 70 mm and the gate thickness 2 mm.

15 [0116]

The existence of bubbles on the surface of the light guide plate was checked by sight, whereupon it was found that there were no bubbles on the surface and the appearance was excellent. Further, the total light transmittance of the light guide plate was 92% and the transparency was all excellent. Further, the mechanical strength was evaluated using this light guide plate, whereupon it was confirmed that the impact resistance was excellent for Examples 1 to 5. For Example 6, however, due to the large ethylene content, a slight decline in the mechanical strength was observed.

[0117]

A reflection tape of Model RF188 made by Tsujimoto Denki Seisakusho was adhered to the side end face of the light guide plate obtained in this way other than the light incident face.

5 A cold cathode tube of a tube diameter of 2.4 mm made by Harrison Electric was placed at the short side light incident end. The area around the tube and the light guide plate incidence part was covered by a reflector of Model GR38W made by Kimoto Co. Further, a light diffusion sheet of Model PCMSA

10 made by Tsujimoto Denki Seisakusho was placed at the light emission face of the light guide plate, while a reflection sheet of Model RF188 made by Tsujimoto Denki Seisakusho was placed at the opposed face of the light emission face of the light guide plate to prepare an edge light type planar light

15 source unit. This unit was used to evaluate the total light transmittance, luminance unevenness, and heat resistance. The results are summarized in Table 1.

[0118]

Comparative Example 1

20 The same procedure was performed as in Production Example 1 except for making the reaction time 62 minutes to obtain an ethylene-NB copolymer (F) having an MFR of 40 [g/10min.], a 50% breaking energy of 0.95J, a Tg of 139°C, a refractive index of 1.53, and an NB content of 53%. This

25 was molded under similar molding conditions as in Example 1

to obtain a wedge-shaped light guide plate having V-groove shapes.

[0119]

The light guide plate obtained had the thin-walled part  
5 of the wedge shape unfilled and exhibited transfer defects  
of the V-grooves. The mechanical strength was extremely good,  
but when evaluating the total light transmittance, luminance  
unevenness, and heat resistance using a planar light source  
the same as in Example 1, while the heat resistance was  
10 extremely good, luminance unevenness occurred and the light  
scattered in the light guide plate due to transfer defects  
of the V-grooves. As a result, the total light transmittance  
also fell. Note that whether there were bubbles in the surface  
of the light guide plate was confirmed by sight, whereupon  
15 it was found there were bubbles in the surface. The results  
are shown in Table 1.

20

25



[0120]

[Table 1]

	Resin	MFR [g/10min.]	Breaking Energy (J)	NB Content mol%	T <sub>g</sub> °C	Entire Light Transmittance %	Luminance Unevenness	Appearance Moldability	Heat Resistance	Mechanical Strength
Example 1	Ethylene/NB (A)	55	0.63	53	140	92	○	○	◎	◎
Example 2	Ethylene/NB (B)	65	0.48	53	141	92	◎	◎	◎	◎
Example 3	Ethylene/NB (C)	178	0.31	55	141	92	◎	◎	◎	◎
Example 4	Ethylene/NB (D)	52	0.19	43	123	91	○	○	○	○
Example 5	Ethylene/NB (E)	203	0.10	53	142	92	◎	△	◎	○
Example 6	Ethylene/NB (F)	53	0.03	33	105	89	○	○	○	△
Comparative Example 1	Ethylene/NB (G)	40	0.95	53	139	90	×	×	◎	◎

[0121]

[Effects of the Invention]

According to the present invention, there is provided a light guide plate with a good appearance and reduced  
5 irregularity in luminance, in particular a thin-walled, large screen size (for example, at least 14 inches size) light guide plate, and a process for production of the same.

In particular, a thermoplastic resin having an MFR of at least 50 [g/10min.] has a low viscosity. Therefore,  
10 according to the present invention using such a resin, the melt fluidity of the resin at the time of melt molding can be improved and a shaped article (light guide plate) having a good appearance can be obtained. In particular, if a resin with a low viscosity is used when molding a thin-walled, large  
15 screen light guide plate, fluidization and plasticization become possible even at a low temperature and cooling and solidification become easy. Further, since the melt fluidity is good, it is possible to precisely transfer even a pattern of fine shapes such as V-grooves to the reflection face side  
20 of the light guide plate. Further, the cycle time at the time of molding is comparatively short, the productivity of the light guide plate rises, the residence time in the molten state becomes shorter, and the rate of occurrence of voids, burn marks, and discoloration falls. Therefore, it becomes  
25 easy to obtain a light guide plate with a good appearance and

reduced irregularity in luminance even when producing a thin-walled, large screen size (for example, at least 14 inches size) light guide plate.

[BRIEF DESCRIPTION OF THE DRAWINGS]

5           [FIG. 1]     FIG. 1(A) is a perspective view showing the outline of a planar light source device including a light guide plate of the present embodiment, FIG. 1(B) is a sectional view of FIG. 1(A), FIG. 1(C) is an enlarged view of principal parts of FIG. 1(B), and FIG. 1(D) is a partially  
10 enlarged view of the reflection face of FIG. 1(C)

          [FIG. 2]     FIG. 2(A) to FIG. 2(E) are schematic views showing the process of production of a light guide plate according to the first embodiment of the present invention.

          [FIG. 3]     FIG. 3(A) is a right side view of a light  
15 guide plate produced by the process of FIG. 2, and FIG. 3(B) is a bottom view of FIG. 3(A).

[Explanation of References]

1: hopper  
2: heating cylinder  
20       21: nozzle  
3: screw  
4: mold  
5: injection cylinder  
10: planar light source device  
25   100: light guide plate

100a: light incidence face

1001: V-grooves

100b: light emission face

100c: light reflection face

5 100d: end portion light reflection face

200: light source

300: lamp reflector

400: light diffusion sheet

500: light reflection sheet

10 600: gate marks

# FIG. 1

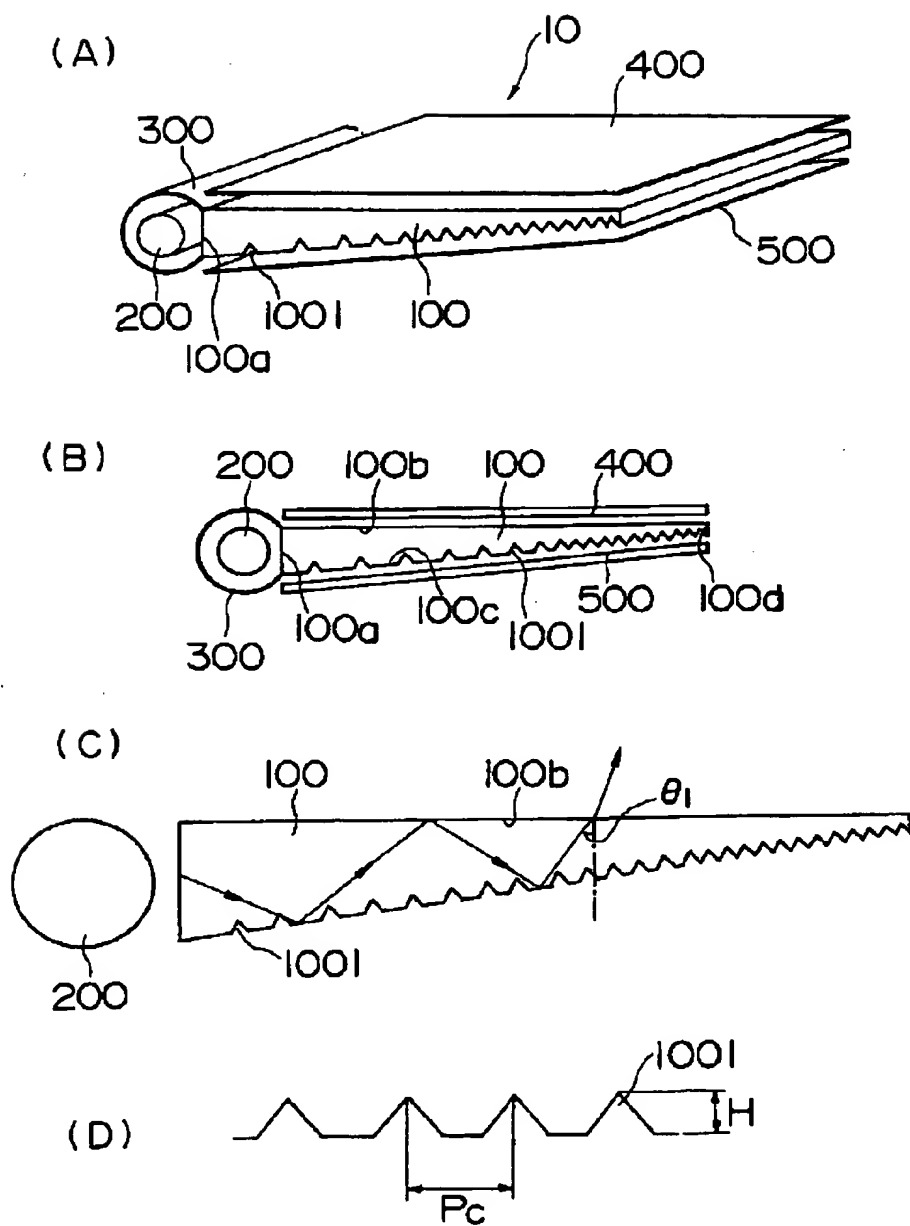


FIG.2

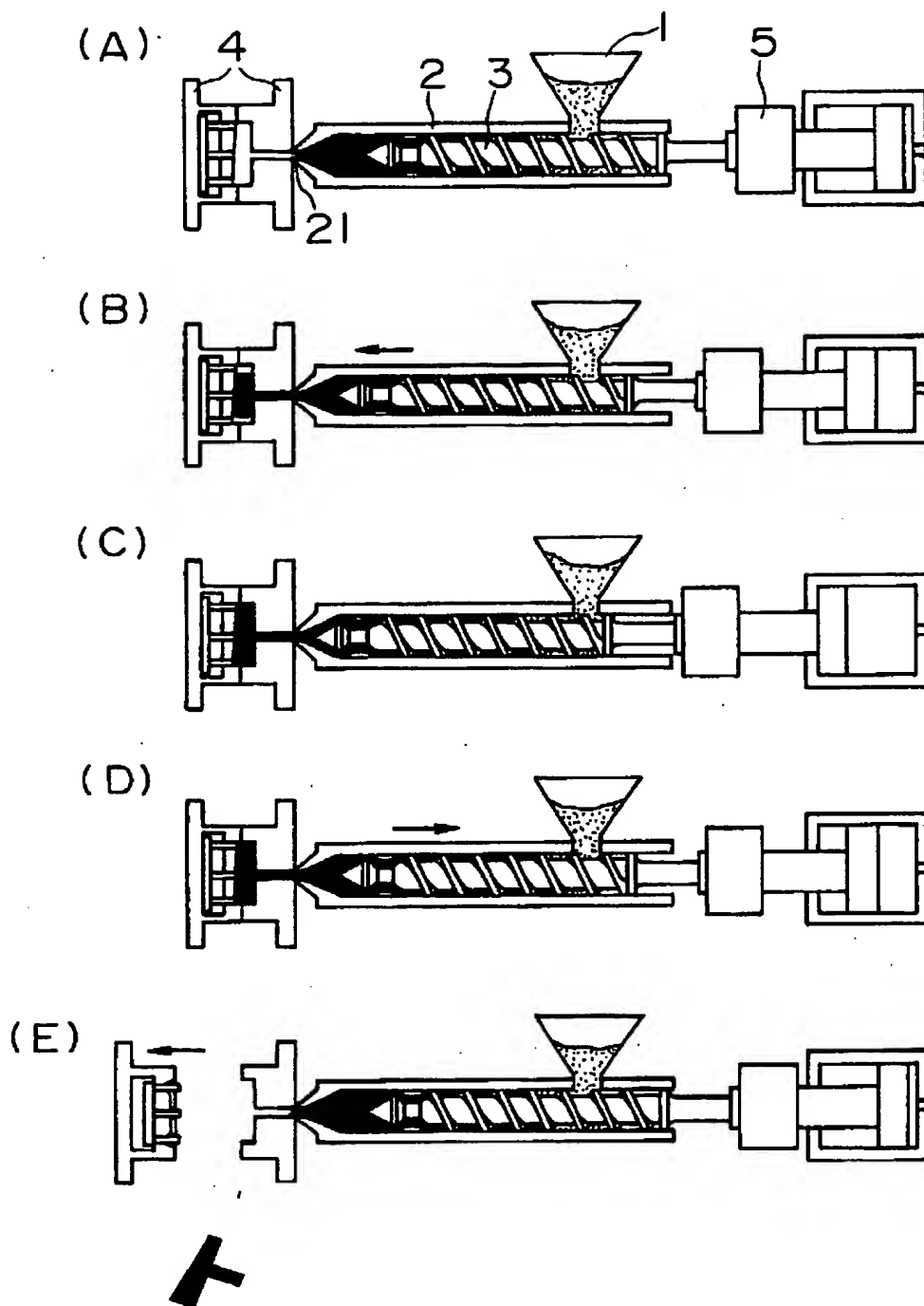
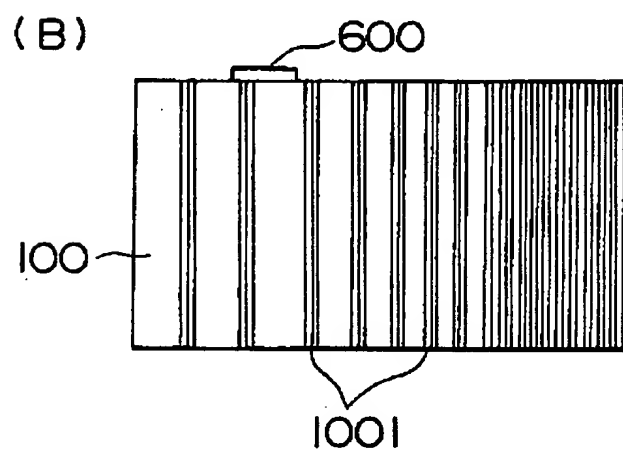
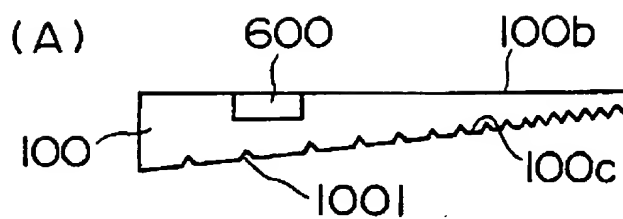


FIG.3



[DOCUMENT NAME] Abstract

[ABSTRACT]

[Problems] To provide a light guide plate of a good appearance and reduced irregularity in luminance, in particular a thin-walled, large screen size light guide plate, and a process for production of the same.

[Means for Solution] A light guide plate characterized by being obtained by performing melt molding a thermoplastic resin having a melt flow rate of at least 50 [g/10min.] under a load of 2.16 kgf at 280°C. The thermoplastic resin is preferably a thermoplastic resin containing an alicyclic structure, more preferably a norbornene-based polymer.

[Selected Figure] FIG. 1



C E R T I F I C A T E

I, Koichiro OHKURA, a member of MAEDA & NISHIDE of Kiriya Bldg., 1-1, Sarugaku-cho 2-chome, Chiyoda-ku, Tokyo, Japan hereby declare that I am conversant with the Japanese and the English languages and that I am the translator of the document attached and certify that to the best of my knowledge and belief the following is a true and correct English translation of the specification of Japanese Patent Application No. 11-22049 in the name of Nippon Zeon co., Ltd..

Signed this 10 day of March 2004

Koichiro Ohkura  
Koichiro OHKURA

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[ Number of register of payment ] 043339

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[ List of Submitted Objects ]

[ Name of Object ]	Specification	1
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[ Name of Object ]	Drawings	1
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[ Name of Object ]	Abstract	1
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[ Demand of Proof ] Necessary

[DOCUMENT NAME] Specification\_\_\_\_\_

[TITLE OF THE INVENTION] Light Guide Plate

[CLAIMS]

[Claim 1] A light guide plate characterized by being  
5 comprised of a thermoplastic resin containing an alicyclic  
structure, wherein

a ratio of a repeating unit having alicyclic structure  
at its main chain and side chains in all repeating units in  
a polymer is 50 to 100 mol%, and

10 the melt flow rate measured at 280°C with a load of 2.16  
kgf based on JIS-K-6719 is 20 to 300 [g/10min.].

[Claim 2] The light guide plate as set forth in claim  
1, wherein said thermoplastic resin containing an alicyclic  
structure is a hydrogenate of a norbornene based ring-opening  
15 polymer.

[Claim 3] A method of producing a light guide plate  
characterized by performing melt molding a thermoplastic  
resin containing an alicyclic structure, wherein

a ratio of a repeating unit having alicyclic structure  
20 at its main chain and side chains in all repeating units in  
a polymer is 50 to 100 mol%, and

the melt flow rate measured at 280°C with a load of 2.16  
kgf based on JIS-K-6719 is 20 to 300 [g/10min.].

[Claim 4] The method of producing the light guide  
25 plate as set forth in claim 3, wherein said melt molding is

injection molding.

[DETAILED DESCRIPTION OF THE INVENTION]

[0001]

[Technical Field of the Invention]

5       The present invention relates to a light guide plate and a production method thereof, more particularly to a light guide plate with an excellent appearance, high luminance (particularly, high front luminance), reduced irregularity in luminance and excellent mechanical strength, and a  
10   production method of the same.

[0002]

[Prior Art]

      A light guide plate is one of optical members used in a backlight unit mounted in various display devices. For  
15   example, an edge light type planar light source device is generally comprised of a light guide plate for guiding light from a light source entering from a side end face in a direction parallel to the plate face and causing it to be emitted, a reflector arranged so as to surround the light source for  
20   efficiently guiding the light of the light source not directly entering the light source-side end face of the light guide plate to the guide light plate, a light diffusion sheet arranged at the light emitting face side of the light guide plate for causing diffusion of light emitted from the emission  
25   face, and a reflection sheet arranged at the light reflection

face side of the light guide plate for returning the light leaked from the light guide plate to the light guide plate once again.

[0003]

5       Note that the back face of the light guide plate (light reflection face) is formed with a pattern of various shapes such as dots, cone cuts, and V-grooves for raising or uniformly diffusing the luminance of the light introduced into the light guide plate.

10       [0004]

The light guide plate is required to have high transparency and reduced irregularity in luminance to attain high luminance. Therefore, conventionally, use has been made of a light guide plate made by injection molding a colorless  
15 highly transparent thermoplastic resin such as polymethyl methacrylate (PMMA) or polycarbonate (PC).

[0005]

[Problems to be Solved by the Invention]

The PMMA has a high melt viscosity at the time of  
20 injection molding and a shape of a light guide plate to be made was limited. On the other hand, if the resin temperature is raised to improve the fluidity, the resin is liable to foam in the cylinder and a shaped article with a good appearance is difficult to obtain such as due to the occurrence of voids.  
25 Further, since PC has a high heat deformation temperature,

but also has a high heat-deformation temperature compared with PMMA, the molding temperature has to be raised in order to obtain sufficient fluidity. As a result, due to the effects of moisture absorption, the resin is liable to hydrolyze and foam in the cylinder. In the same way as the case of PMMA, voids occurred in the shaped article and it was difficult to obtain a shaped article with a good appearance. Therefore, there are demands for a molding material capable of stably forming a high quality shaped articles without causing any molding defects by injection molding.

[0006]

Further, when using PMMA or PC as the molding material and forming a fine pattern of V-grooves etc. on the back face of the light guide plate, there has been the problem that it was not possible to precisely transfer the pattern of the fine shapes to the light reflection face side of the thinnest part, that is, the narrow end portion, in a wedge-shaped light guide plate where the thickness of the light guide plate becomes gradually thinner, the further from the light source. This becomes a cause of a reduction of the homogeneity of the light to be emitted due to luminance unevenness.

[0007]

Thus, there has been a proposal of using as a light guide plate a random copolymer of tetracyclododecene and ethylene as thermoplastic resin having an alicyclic structure to solve

the above problems of PMMA and PC as above in the Japanese Patent Publication No. 9-40787 and No. 10-87752.

[0008]

However, there has been a problem that the random  
5 copolymer described in the above publications have a small  
copolymer ratio of tetracyclododecene as a repeating unit  
having alicyclic structure, not capable of obtaining  
sufficient luminance due to poor transparency, and mechanical  
strength is not sufficient.

10 [0009]

From the above, a light guide plate having good  
appearance, high luminance, low unevenness of luminance,  
furthermore, excellent mechanical strength was yet to be  
obtained.

15 [0010]

The present invention was made in consideration of the  
above circumstances and has as an object thereof to provide  
a light guide plate with an excellent appearance, reduced  
irregularity in luminance, and excellent mechanical strength,  
20 and a method of producing the same.

[0011]

[Means for Solving the Problem]

The present inventors took note of the melt fluidity  
of a thermoplastic resin and a structure of a repeating unit,  
25 and engaged in intensive studies with the aim of improving



it. As a result, they discovered that by performing melt molding a thermoplastic resin containing an alicyclic structure having a specific melt flow rate (hereinafter also referred to as an "MFR") wherein all repeating units have a specific amount of alicyclic structure, it is possible to obtain a light guide plate with a good appearance, high luminance, reduced irregularity in luminance and excellent mechanical strength, and thereby completed the present invention.

10 [0012]

Namely, a "light guide plate" according to the present invention is characterized by being comprised of a thermoplastic resin containing an alicyclic structure, wherein a ratio of a repeating unit having alicyclic structure at its main chain and side chains in all repeating units in a polymer is 50 to 100 mol%, and the melt flow rate measured at 280°C with a load of 2.16 kgf based on JIS-K-6719 is 20 to 300 [g/10min.].

[0013]

20 Also, a "method of producing a light guide plate" according to the present invention is characterized by performing melt molding a thermoplastic resin containing an alicyclic structure, wherein a ratio of a repeating unit having alicyclic structure at its main chain and side chains in all repeating units in a polymer is 50 to 100 mol%, and

25

the melt flow rate measured at 280°C with a load of 2.16 kgf based on JIS-K-6719 is 20 to 300 [g/10min.].

[0014]

It is sufficient if the thermoplastic resin containing  
5 an alicyclic structure has the ratio of repeating units having alicyclic structure at its main chain and side chains to all repeating units in the polymer of at least 50 to 100 mol%, but preferably 70 to 100 mol%, more preferably 90 to 100 mol%, particularly preferably 100 mol%. When the ratio of repeating  
10 units having alicyclic structure in the thermoplastic resin containing an alicyclic structure is excessively small, it is not preferable because light transmittance declines, a light introduced from the incidence face of the light guide plate cannot be effectively transferred to its opposing face,  
15 furthermore, the front luminance declines and the mechanical strength also declines. Also, when the ratio of the ratio of repeating units having alicyclic structure is excessively small, thermal deformation is liable to be caused, which is unfavorable.

20 [0015]

It is sufficient if the thermoplastic resin containing an alicyclic structure has the MFR measured at 280°C with a load of 2.16 kgf based on JIS-K-6719 is at least 20 to 300 [g/10min.], but preferably 30 to 300 [g/10min.], more  
25 preferably 50 to 250 [g/10min.], and particularly preferably

50 to 200 [g/10min.]. When the MFR of the thermoplastic resin containing an alicyclic structure is excessively low, moldability becomes poor, such that melting fluidity declines, transferability of fine shapes becomes poor, and it cannot  
5 be sufficiently filled in a thin shaped article with a wide screen size, which is unfavorable. While, when the MFR is excessively high, disadvantages arise, such that the mechanical strength of the shaped article becomes weak and thin and wide screen sized article cannot be obtained. Namely,  
10 by setting the MFR in the range, particularly the mechanical strength and moldability (fluidity of the resin at the time of molding) of the obtained shaped article are highly balanced.

[0016]

15 As the thermoplastic resin containing an alicyclic structure, a hydrogenate of a norbornene based ring-opening polymer is preferable.

[0017]

In the case where the thermoplastic resin containing  
20 an alicyclic structure is a hydrogenate of a norbornene based ring-opening polymer, those including a bond unit originating from a norbornene based monomer not having norbornene structure by preferably 10 wt% or more, more preferably 20 wt% or more, and particularly preferably 30 wt% or more in  
25 all bond units originating from the norbornene based monomer

are preferable because it has the excellent mechanical strength. Thus, even when the MFR of the hydrogenate of a norbornene based ring-opening polymer becomes high, a thinner light guide plate with a larger screen size can be produced, and it is preferable to be used in an edge light type light guide plate having a long light path because a problem of becoming yellowish is not caused due to its excellent light stability.

[0018]

10 Injection molding is preferable as the above melt molding.

[0019]

[Operation]

Since a thermoplastic resin containing an alicyclic structure having the above specific MFR has low melt viscosity and excellent melt fluidity of the resin at the time of melt molding, when forming by transferring a fine pattern, such as V-grooves, on the reflection face of the light guide plate, accurate transfer is possible, irregularity in luminance is improved, thermal decomposition and hydrolysis of a resin are scarcely caused even under a high temperature condition, and a shaped article (light guide plate) having a good appearance can be obtained. Also, a thermoplastic resin containing an alicyclic structure wherein all repeating units have a repeating unit having a specific amount of alicyclic

15  
20  
25

structure has excellent optical characteristics, such as transparency, so that decline of luminance is a little even on a long light path, luminance is improved very much and mechanical strength is also improved. Therefore, a light  
5 guide plate having sufficient mechanical strength can be obtained particularly even when molding a thin and wide light guide plate.

Accordingly, according to the present invention, it is possible to provide a light guide plate having a good  
10 appearance, high luminance, reduced irregularity of luminance and mechanical strength.

[0020]

In addition to the above, by using a specific resin of the above present invention, heat resisting property is given  
15 to a light guide plate as a shaped article, and deformation is not caused by temperature changes even when the light guide plate is used for a long time, so that it is suitable to being used as a light guide plate.

[0021]

20 Also, particularly, when molding a light guide plate by using the above specific resin having a certain amount or more of specific structure units and a specific range of MFR, by applying melt molding, particularly preferably melt injection molding, as the molding method, molding in a range  
25 of good fluidity and plasticity not causing molding defects

at the time of melting becomes possible, and cooling and curing of the shaped article become easy. Furthermore, a pattern of fine shapes, such as V-grooves on the reflection face side of the light guide plate can be accurately transferred. Furthermore, since melt viscosity is low and fluidity is secured even when a resin temperature is lowered, there are also effects that cycle time at the time of molding is relatively short, productivity of the shaped article is improved, the residence time in a molten state becomes short and the rate of occurrence of voids, burn marks, and discoloration falls.

Also, the above specific resin is also preferable when using preferable injection molding for molding a highly precise light guide plate as the above for not declining the mechanical strength.

Accordingly, according to the present invention, it is possible to easily produce a light guide plate having a high front luminance, decreased irregularity in luminance and excellent mechanical strength.

[0022]

[Embodiments of the Invention]

Below, an embodiment of the present invention will be explained.

[0023]

Thermoplastic resin containing an alicyclic structure

A thermoplastic resin containing an alicyclic structure used in the present invention is one having alicyclic structure at its main chain and/or side chains, and one having alicyclic structure at its main chain is preferable  
5 in terms of mechanical strength and heat resistance.

[0024]

As an alicyclic structure, a saturated ring hydrocarbon (cycloalkane) structure, unsaturated ring hydrocarbon (cycloalkene), etc. may be mentioned, and those having  
10 cycloalkane structure are preferable in terms of mechanical strength and heat resistance, etc. The number of carbon atoms making up the alicyclic structures is not particularly limited, but is usually 4 to 30, preferably 5 to 20, more preferably 5 to 15. In this range, the properties of the  
15 mechanical strength, heat resistance, and moldability are well balanced.

[0025]

Also, a ratio of repeating units having alicyclic structure in the all repeating units of the thermoplastic  
20 resin containing an alicyclic structure is normally 50 to 100 mol%.

[0026]

As a preferable example of a thermoplastic resin containing an alicyclic structure having alicyclic structure  
25 as such, a norbornene based ring opening polymer hydrogenate

may be mentioned. A norbornene based ring opening polymer hydrogenate has high mechanical strength and is particularly preferable to producing a recent light guide plate which is thin and wide in size.

5 [0027]

A norbornene based ring opening polymer hydrogenate is a well known polymer disclosed, for example, in the Japanese Unexamined Patent Publication No. 3-14882 and No. 3-122137, etc. and is produced by (co)polymerizing a norbornene based  
10 monomer or other monomer which can be copolymerized with a norbornene based monomer and furthermore hydrogenating.

[0028]

As the norbornene-based monomers, for example,  
bicyclo[2,2,1]-hept-2-ene (commonly called "norbornene"),  
15 5-methyl-bicyclo[2,2,1]-hept-2-ene,  
5,5-dimethyl-bicyclo[2,2,1]-hept-2-ene,  
5-ethyl-bicyclo[2,2,1]-hept-2-ene,  
5-butyl-bicyclo[2,2,1]-hept-2-ene,  
5-hexyl-bicyclo[2,2,1]-hept-2-ene,  
20 5-octyl-bicyclo[2,2,1]-hept-2-ene,  
5-octadecyl-bicyclo[2,2,1]-hept-2-ene,  
5-ethylidene-bicyclo[2,2,1]-hept-2-ene,  
5-methylidene-bicyclo[2,2,1]-hept-2-ene,  
5-vinyl-bicyclo[2,2,1]-hept-2-ene,  
25 5-propenyl-bicyclo[2,2,1]-hept-2-ene,



- 5-methoxy-carbonyl-bicyclo[2,2,1]-hept-2-ene,  
 5-cyano-bicyclo[2,2,1]-hept-2-ene,  
 5-methyl-5-methoxycarbonyl-bicyclo[2,2,1]-hept-2-ene;  
 5-methoxycarbonyl-bicyclo[2,2,1]-hept-2-ene,  
 5 5-ethoxycarbonyl-bicyclo[2,2,1]-hept-2-ene,  
 5-methyl-5-methoxycarbonyl-bicyclo[2,2,1]-hept-2-ene,  
 5-methyl-5-ethoxycarbonyl-bicyclo[2,2,1]-hept-2-ene,  
 bicyclo[2,2,1]-hept-5-enyl-2-methylpropionate,  
     bicyclo[2,2,1]-hept-5-enyl-2-methyloctanate,  
 10 bicyclo[2,2,1]-hept-2-ene-5,6-dicarboxylic acid anhydride,  
 5-hydroxymethyl-bicyclo[2,2,1]-hept-2-ene,  
 5,6-di(hydroxymethyl)-bicyclo[2,2,1]-hept-2-ene,  
 5-hydroxy-i-propyl-bicyclo[2,2,1]-hept-2-ene,  
 bicyclo[2.2.1]-hept-2-ene,  
 15 5,6-dicarboxy-bicyclo[2,2,1]-hept-2-ene,  
 bicyclo[2.2.1]-hept-2-ene-5,6-dicarboxylic acid imide,  
 5-cyclopentyl-bicyclo[2,2,1]-hept-2-ene,  
 5-cyclohexyl-bicyclo[2,2,1]-hept-2-ene,  
 5-cyclohexenyl-bicyclo[2,2,1]-hept-2-ene,  
 20 5-phenyl-bicyclo[2,2,1]hept-2-ene;  
     tricyclo[4,3,0,1<sup>2,5</sup>]-deca-3,7-diene (commonly called  
     "dicyclopentadiene"), tricyclo[4,3,0,1<sup>2,5</sup>]-deca-3-ene;  
     tricyclo[4,4,0,1<sup>2,5</sup>]-undeca-3,7-diene,  
     tricyclo[4,4,0,1<sup>2,5</sup>]-undeca-3,8-diene,  
 25 tricyclo[4,4,0,1<sup>2,5</sup>]-undeca-3-ene,

tetracyclo[7,4,0,1<sup>10,13</sup>,0<sup>2,7</sup>]-trideca-2,4,6-11-tetraene  
 (also called 1,4-methano-1,4,4a,9a-tetrahydrofluorene),  
 tetracyclo[8,4,0,1<sup>11,14</sup>,0<sup>3,8</sup>]-tetradeca-3,5,7,12-11-tetraen  
 e (also called

- 5 1,4-methano-1,4,4a,5,10,10a-hexahydroanthracene), and  
 other norbornene based monomer not having norbornene  
 structure;

tetracyclo[4,4,0,1<sup>2,5</sup>,1<sup>7,10</sup>]-dodeca-3-ene (also simply  
 called tetracyclododecene),

- 10 8-methyl-tetracyclo[4,4,0,1<sup>2,5</sup>,1<sup>7,10</sup>]-dodeca-3-ene,  
 8-ethyl-tetracyclo[4,4,0,1<sup>2,5</sup>,1<sup>7,10</sup>]-dodeca-3-ene,  
 8-methylenetetracyclo[4,4,0,1<sup>2,5</sup>,1<sup>7,10</sup>]-dodeca-3-ene,  
 8-ethylidene-tetracyclo[4,4,0,1<sup>2,5</sup>,1<sup>7,10</sup>]-dodeca-3-ene,  
 8-vinyl-tetracyclo[4,4,0,1<sup>2,5</sup>,1<sup>7,10</sup>]-dodeca-3-ene,  
 15 8-propenyl-tetracyclo[4,4,0,1<sup>2,5</sup>,1<sup>7,10</sup>]-dodeca-3-ene,  
 8-methoxycarbonyl-tetracyclo[4,4,0,1<sup>2,5</sup>,1<sup>7,10</sup>]-dodeca-3-ene,  
 8-methyl-8-methoxycarbonyl-tetracyclo[4,4,0,1<sup>2,5</sup>,1<sup>7,10</sup>]-dodeca-3-ene,

- 8-hydroxymethyl-tetracyclo[4,4,0,1<sup>2,5</sup>,1<sup>7,10</sup>]-dodeca-3  
 20 -ene, 8-carboxy-tetracyclo [4,4,0,1<sup>2,5</sup>,1<sup>7,10</sup>]-dodeca-3-ene,  
 8-cyclopentyl-tetracyclo[4,4,0,1<sup>2,5</sup>,1<sup>7,10</sup>]-dodeca-3-ene,  
 8-cyclohexyl-tetracyclo[4,4,0,1<sup>2,5</sup>,1<sup>7,10</sup>]-dodeca-3-ene,  
 8-cyclohexenyl-tetracyclo[4,4,0,1<sup>2,5</sup>,1<sup>7,10</sup>]-dodeca-3-ene,  
 8-phenyl-cyclopentyl-tetracyclo[4,4,0,1<sup>2,5</sup>,1<sup>7,10</sup>]-dodeca-3-  
 25 ene, pentacyclo-[6,5,1,1<sup>3,6</sup>,0<sup>2,7</sup>,0<sup>9,13</sup>]-pentadeca-3,10-diene,

pentacyclo[7,4,0,1<sup>3,6</sup>,1<sup>10,13</sup>,0<sup>2,7</sup>]-pentadeca-4,11-diene; and other norbornene based monomers having at least one norbornene structure; may be mentioned.

[0029]

5        These norbornene-based monomers may be used alone or in combinations of two or more types.

[0030]

A ratio of repeating units originating from a norbornene based monomer in the norbornene based ring opening  
10 polymer hydrogenate is normally 50 to 100 mol%, preferably 70 to 100 mol%, more preferably 90 to 100 mol%, particularly preferably 100 mol%.

[0031]

Also, as repeating units as a remaining portion other  
15 than the repeating units having alicyclic structure composing the thermoplastic resin containing an alicyclic structure in the present invention, chain repeating units are normally mentioned. But such a chain repeating unit is, for example, other monomers which can be copolymerized with a norbornene  
20 based monomer, and a monomer giving a chain repeating unit by polymerization may be mentioned. Such other monomers which can be polymerized with a norbornene based monomer is not particularly limited and, for example, ethylene, propylene, 1-butene, 1-pentene, 1-hexene, 3-methyl-1-butene,  
25 3-methyl-1-pentene, 3-ethyl-1-pentene, 4-methyl-1-pentene,

4-methyl-1-hexene, 4,4-dimethyl-1-hexene,  
 4,4-dimethyl-1-pentene, 4-ethyl-1-hexene, 3-ethyl-1-hexene,  
 1-octene, 1-decene, 1-dodecene, 1-tetradecene, 1-hexadecene,  
 1-octadecene, 1-eicocene, and other C2 to C20 ethylene or  
 5  $\alpha$ -olefin;

cyclobutene, cyclopentene, cyclohexene,  
 3,4-dimethylcyclopentene, 3-methylcyclohexene,  
 2-(2-methylbutyl)-1-cyclohexene, cyclooctene,  
 3a,5,6,7a-tetrahydro-4,7-methano-1H-indene, and other  
 10 cycloolefins; 1,4-hexadiene, 4-methyl-1,4-hexadiene,  
 5-methyl-1,4-hexadiene, 1,7-octadiene, and other  
 nonconjugated dienes; etc. may be mentioned.

[0032]

The other monomers which can be copolymerized with a  
 15 norbornene based monomer may be used alone or in combination  
 of two or more.

[0033]

A ratio of chain repeating units originating from a  
 monomer which can be copolymerized in a norbornene based ring  
 20 opening polymer hydrogenate as a preferable resin in the  
 present invention is normally 0 to 50 mol%, preferably 0 to  
 30 mol%, more preferably 0 to 10 mol%, particularly preferably  
 0%.

[0034]

25 The ring-opening polymerization of the

norbornene-based monomer or norbornene-based monomer and vinyl-based compound able to be copolymerized with this usually may be performed in the presence of a ring-opening polymerization catalyst and molecular weight adjusting agent.

5 As the ring-opening polymerization catalyst, for example, catalyst systems comprised of halides, nitrates, or acetylacetone compounds of ruthenium, rhodium, palladium, osmium, iridium, platinum, and other metals and reducing agents or catalyst systems comprised of halides or  
10 acetylacetone compounds of metals such as titanium, vanadium, zirconium, tungsten, and molybdenum and organoaluminum compounds may be mentioned.

[0035]

As the molecular weight adjusting agent, normally a  
15 chain-like monoolefin or chain-like conjugated dienes are used, but for example, 1-butene, 2-butene, 1-pentene, 1-hexene, 1-heptene, 1-octene, 1-dodecene, 1,4-hexadiene, etc. may be mentioned. The amount of the molecular weight adjusting agent used is suitably selected according to the  
20 polymerization conditions, but usually is, in terms of a molar ratio with respect to the total monomers, 1/10 to 1/500, preferably 1/25 to 1/250, more preferably 1/50 to 1/200. When in this range, the molecular weight is easy to control and the MFR becomes easy to control. As the method of addition  
25 of a molecular weight adjusting agent, for addition to the

reaction system at a high accuracy, it is preferable to use it diluted by a reaction solvent etc. in advance or add it using an apparatus with a high measurement accuracy. As the accuracy of the amount of the molecular weight adjusting agent  
5 added, normally the range of error of the amount added required for the desired molecular weight is not more than 3%, preferably not more than 2%, more preferably not more than 1%. At this time, the molecular weight can be easily controlled and the MFR can be easily controlled. The  
10 ring-opening polymerization reaction may be performed in a solvent or not in the presence of a solvent at a polymerization temperature of -50 to 100°C and a polymerization pressure of 0 to 50 kg/cm<sup>2</sup>.

[0036]

15 A hydrogenate of the ring-opening polymer of the norbornene-based monomer may be produced by an ordinary method. Specifically, it may be obtained by hydrogenation of a polymerization solution of a ring-opening polymer of the above norbornene-based monomer in the presence of a  
20 hydrogenation catalyst. The hydrogenation catalyst is not particularly limited, but normally a nonhomogeneous catalyst or homogeneous catalyst is used.

[0037]

As the nonhomogeneous catalyst, for example, nickel,  
25 palladium, platinum, or nickel/silica, nickel/diatomaceous

earth, nickel/alumina, palladium/carbon, palladium/silica, palladium/diatomaceous earth, palladium/alumina, etc. may be mentioned. As the homogeneous catalyst, for example, a catalyst comprised of a combination of a transition metal compound and alkylaluminum metal compound or alkyl lithium, for example, a catalyst comprised of a combination of cobalt acetate/triethylaluminum, cobalt acetate/triisobutyl-aluminum, nickel acetate/triethylaluminum, nickel acetate/triisobutylaluminum, nickel acetylacetonate/tri-ethylaluminum, nickel acetylacetonate/triisobutyl-aluminum, titanocene chloride/n-butyllithium, zirconocene chloride/n-butyllithium, etc. may be mentioned. These hydrogenated catalysts may be used alone or in combinations of two or more types. The amount of the hydrogenated catalyst used is normally 0.01 to 100 parts by weight, preferably 0.1 to 50 parts by weight, more preferably 1 to 30 parts by weight with respect to 100 parts by weight of a ring-opening polymer of a norbornene-based monomer. The hydrogenation reaction is normally performed under a hydrogen pressure of 1 to 150 kg/cm<sup>2</sup>, a temperature range of 0 to 250°C, and a reaction time of 1 to 20 hours.

[0038]

The weight average molecular weight (Mw) of the

thermoplastic resin containing an alicyclic structure used in the present invention is, converted to polyisoprene by high pressure liquid chromatography using cyclohexane as a mobile phase, normally 10,000 to 100,000, preferably 13,000 to 70,000, more preferably 14,000 to 60,000, particularly preferably 15,000 to 50,000. When the Mw is in this range, the mechanical strength and moldability of the light guide plate obtained are well balanced.

[0039]

10       The molecular weight distribution (MWD), expressed by the ratio ( $M_w/M_n$ ) of  $M_w$  and the number average molecular weight of the thermoplastic resin containing an alicyclic structure of the present invention, is usually not more than 4.0, preferably not more than 3.0, more preferably not more than 2.7, particularly preferably not more than 2.5. When the  
15       molecular weight distribution is in this range, the mechanical strength and moldability of the light guide plate obtained are well balanced.

[0040]

20       A glass transition temperature ( $T_g$ ) of a thermoplastic resin containing an alicyclic structure used in the present invention may be suitably selected in accordance with use object, but the higher is the better in a use environment of the light guide plate. It is normally 70°C or more, preferably  
25       70 to 250°C, more preferably 80 to 200°C. When in the range,



heat resistance and moldability are highly balanced and preferable.

[0041]

The refractive index of the thermoplastic resin  
5 containing an alicyclic structure used in the present  
invention measured at 25°C based on ASTM-D542 may be suitably  
selected in accordance with an use object, but is normally  
1.46 to 1.60, preferably 1.50 to 1.60, more preferably 1.52  
to 1.56. When in the range, it is preferable for an edge light  
10 type light guide plate having a reflection face.

[0042]

Note that these thermoplastic resin containing an  
alicyclic structure may be used alone or in combination of  
two or more kinds.

15 [0043]

A specific thermoplastic resin containing an alicyclic  
structure composing the light guide plate of the present  
invention can be molded at a high temperature without causing  
heat decomposition or hydrolysis and has superior fluidity  
20 at the time of melting to that of other thermoplastic resins,  
so that it is preferable because transfer defective is not  
caused and irregularity of luminance is reduced when forming  
a pattern of fine shapes of V-grooves, etc. on the reflection  
surface of the light guide plate.

25 [0044]

### Other Ingredients

The molding material for molding the "light guide plate" according to the present invention may, as needed, include components other than the above thermoplastic resin containing an alicyclic structure. As the examples of the other components, (a) other resins, (b) soft polymers and (c) compounding agents, etc. may be mentioned. These components may be used alone or in combination of two or more, and a blending amount is suitably selected in a range of not undermining the object of the present invention.

[0045]

#### (a) Other resin

As a resin other than the thermoplastic resin containing an alicyclic structure used in the present invention, for example, polystyrene, poly(metha)acrylate, polycarbonate, polyester, polyether, polyamide, polyimide and polysulfone, etc. may be mentioned.

[0046]

#### (b) Soft polymer

The soft polymer usually means a polymer having a glass transition temperature ( $T_g$ ) of not more than  $40^\circ\text{C}$ . In the case of a polymer having several  $T_g$  and a polymer having both the  $T_g$  and melting point ( $T_m$ ), any polymer having a lowest  $T_g$  of not more than  $40^\circ\text{C}$  is included in such a soft polymer.

[0047]

As a soft polymer, for example, isoprene rubber and a hydrogenate thereof; chloroprene rubber and a hydrogenate thereof; an ethylene propylene copolymer, an ethylene  $\alpha$ -olefin copolymer, a propylene  $\alpha$ -olefin copolymer and other saturated polyolefin rubbers; an ethylene propylene diene copolymer, an  $\alpha$ -olefin diene copolymer, a diene copolymer, an isobutylene isoprene copolymer, an isobutylene diene copolymer and other diene copolymers, halides of these, a diene based polymer or hydrogenate of the halide; an acrylonitrile butadiene copolymer, a hydrogenate thereof; a vinylidene fluoride ethylene trifluoride copolymer, a vinylidene fluoride hexafluoride propylene copolymer, a vinylidene fluoride hexafluoride propylene ethylene tetrafluoride copolymer, a propylene ethylene tetrafluoride copolymer and other fluoride rubbers; urethane rubber, silicone rubber, polyether based rubber, acrylic rubber, chlorosulfone polyethylene rubber, epichlorohydrin rubber, propylene oxide rubber, ethylene acrylic rubber and other special rubbers;

a tercopolymer of a norbornene based monomer and ethylene and  $\alpha$ -olefin, a ring-opening polymer of a norbornene based monomer, a hydrogenate of a ring-opening polymer of a norbornene based monomer and other norbornene based soft polymers; styrene butadiene rubber subjected to emulsion polymerization or solution polymerization, a random or block

styrene butadiene based copolymer of high styrene rubber,  
etc., hydrogenates of these; a random copolymer of aromatic  
vinyl based rubber, such as styrene butadiene styrene rubber,  
styrene isoprene, styrene rubber, styrene ethylene butadiene  
5 styrene rubber, and conjugated diene, hydrogenates of these;  
a straight-chain or radial block copolymer of an aromatic  
based vinyl based monomer, such as styrene butadiene styrene  
rubber, styrene isoprene styrene rubber and styrene ethylene  
butadiene styrene rubber, and conjugated diene, hydrogenates  
10 of these and other styrene based thermoplastic elastomers,  
urethane based thermoplastic elastomer, polyamide based  
thermoplastic elastomer, 1,2-polybutadiene based  
thermoplastic elastomer, vinyl chloride based thermoplastic  
elastomer, fluoride based thermoplastic elastomer and other  
15 thermoplastic elastomers; etc. may be mentioned.

[0048]

(c) Compounding Agent

Compounding agents are not particularly limited so long  
as they are those generally used in the plastic industry.  
20 Specifically, an antioxidant, UV absorbent, photostabilizer,  
near infrared absorbent, dye, pigment, or other coloring  
agent, plasticizer, and filler may be mentioned.

[0049]

As the antioxidant, a phenol-based antioxidant,  
25 phosphorus-based antioxidant, sulfur-based antioxidant, etc.

may be mentioned. Among these, a phenol-based antioxidant is preferable. An alkyl-substituted phenol-based antioxidant is particularly preferable.

[0050]

5       As the phenol-based antioxidant, conventionally known ones may be used. For example,  
 2-t-butyl-6-(3-t-butyl-2-hydroxy-5-methylbenzyl)-4-methylphenylacrylate,  
 2,4-di-t-amyl-6-(1-(3,5-di-t-amyl-2-hydroxyphenyl)ethyl)phenylacrylate, and other acrylate-based compounds described  
 10 in Japanese Unexamined Patent Publication (Kokai) No. 63-179953 or Japanese Unexamined Patent Publication (Kokai) No. 1-168643;  
 octadecyl-3-(3,5-di-t-butyl-4-hydroxyphenyl)propionate,  
 15 2,2'-methylene-bis(4-methyl-6-t-butylphenol),  
 1,1,3-tris(2-methyl-4-hydroxy-5-t-butylphenyl)butane,  
 1,3,5-trimethyl-2,4,6-tris(3,5-di-t-butyl-4-hydroxybenzyl)benzene,  
 tetrakis(methylene-3-(3',5'-di-t-butyl-4'-hydroxyphenyl)propionate)methane [that is,  
 20 pentaerythrimethyl-tetrakis(3-(3,5-di-t-butyl-4-hydroxyphenyl)propionate)], triethylene glycol  
 bis(3-(3-t-butyl-4-hydroxy-5-methylphenyl)propionate),  
 and other alkyl-substituted phenol-based compounds;  
 25 6-(4-hydroxy-3,5-di-t-butylanilino)-2,4-bis(octylthio)-1,3,

5-triazine, 4-bis-octylthio-1,3,5-triazine,  
2-octylthio-4,6-bis-(3,5-di-t-butyl-4-oxyanilino)-1,3,5-triazine, or other triazine base-containing phenol-based compounds, etc. may be mentioned.

5 [0051]

The phosphorus-based antioxidant is not particularly limited so long as it is one which is usually used in the general plastics industry. For example, triphenylphosphate, diphenylisodecyl-phosphate, phenyldiisodecylphosphate,  
10 tris(nonylphenyl)phosphate, tris(dinonylphenyl)-phosphate, tris(2,4-di-t-butylphenyl)phosphate,  
10-(3,5-di-t-butyl-4-hydroxybenzyl)-9,10-dihydro-9-oxa-10-phosphaphenanthren-10-oxide, and other monophosphate-based compounds;  
15 4,4'-butylidene-bis(3-methyl-6-t-butylphenyl-di-tridecylphosphate), 4,4'-isopropylidene-bis(phenyl-di-alkyl(C<sub>12</sub> to C<sub>15</sub>) phosphate), and other diphosphate-based compounds etc. may be mentioned. Among these, a monophosphate-based compound is preferable. Tris(nonylphenyl)phosphate,  
20 tris(dinonylphenyl)phosphate, tris(2,4-di-t-butylphenyl)phosphate, etc. are particularly preferred.

[0052]

As the sulfur-based antioxidant, for example, dilauryl  
25 3,3'-thiodipropionate, dimyristyl 3,3'-thiodipropionate,

distearyl 3,3-thiodipropionate, laurylstearyl  
 3,3-thiodipropionate,  
 pentaerythritol-tetrakis-( $\beta$ -lauryl-thio-propionate,  
 3,9-bis(2-dodecylthioethyl)-2,4,8,10-tetraoxaspiro[5,5]un  
 5 decane, etc. may be mentioned.

[0053]

As the UV absorbent, for example,  
 2-(2-hydroxy-5-methylphenyl)-2H-benzotriazole,  
 2-(3-t-butyl-2-hydroxy-5-methylphenyl)-5-chloro-2H-benzot  
 10 riazole,  
 2-(3,5-di-t-butyl-2-hydroxyphenyl)-5-chloro-2H-benzotriaz  
 ole, 2-(3,5-di-t-butyl-2-hydroxyphenyl)-2H-benzotriazole,  
 5-chloro-2-(3,5-di-t-butyl-2-hydroxyphenyl)-2H-benzotriaz  
 ole, 2-(3,5-di-t-amyl-2-hydroxyphenyl)-2H-benzotriazole,  
 15 and other benzotriazole-based UV absorbents;  
 4-t-butylphenyl-2-hydroxybenzoate,  
 phenyl-2-hydroxybenzoate,  
 2,4-di-t-butylphenyl-3,5-di-t-butyl-4-hydroxybenzoate,  
 hexadecyl-3,5-di-t-butyl-4-hydroxybenzoate,  
 20 2-(2H-benzotriazol-2-yl)-4-methyl-6-(3,4,5,6-tetrahydroph  
 thalimidylmethyl)phenol,  
 2-(2-hydroxy-5-t-octylphenyl)-2H-benzotriazole,  
 2-(2-hydroxy-4-octylphenyl)-2H-benzotriazole, and other  
 benzoate-based UV absorbents; 2,4-dihydroxybenzophenone,  
 25 2-hydroxy-4-methylbenzophenone,

2-hydroxy-4-methoxybenzophenone-5-sulfonate 3-hydrate,  
 2-hydroxy-4-octyloxybenzophenone,  
 4-dodecaloxy-2-hydroxybenzophenone,  
 4-benzyloxy-2-hydroxybenzophenone,  
 5 2,2',4,4'-tetrahydroxy-benzophenone,  
 2,2'-dihydroxy-4,4'-dimethoxybenzo-phenone, and other  
 benzophenone-based UV absorbents;  
 ethyl-2-cyano-3,3-diphenylacrylate,  
 2'-ethylhexyl-2-cyano-3,3-diphenylacrylate, and other  
 10 acrylate-based UV absorbents; nickel  
 [2,2'-thiobis(4-t-octylphenolate)]-2-ethylhexylamine, and  
 other metal complex-based UV absorbents etc. may be  
 mentioned.

As photostabilizers, for example,  
 15 2,2,6,6-tetramethyl-4-piperidylbenzoate,  
 bis(2,2,6,6-tetramethyl-4-piperidyl)sebacate,  
 bis(1,2,2,6,6-pentamethyl-4-piperidyl)-2-(3,5-di-t-butyl-  
 4-hydroxybenzyl)-2-n-butylmalonate,  
 4-(3-(3,5-di-t-butyl-4-hydroxyphenyl)propionyloxy)-1-(2-(  
 20 3-(3,5-di-t-butyl-4-hydroxyphenyl)propionyloxy)ethyl)-2,2  
 ,6,6-tetramethylpiperidine, and other hindered amine-based  
 photostabilizers may be mentioned.

[0054]

As the near infrared absorbent, for example,  
 25 cyanine-based near infrared absorbents; pyrylium-based



infrared absorbents; squalilium-based near infrared absorbents; croconium-based UV absorbents; azulanium-based near infrared absorbents; phthalocyanine-based near infrared absorbents; dithiol metal complex-based near infrared absorbents; naphthoquinone-based near infrared absorbents; anthraquinone-based near infrared absorbents; indophenol-based near infrared absorbents; azi-based near infrared absorbents; etc. may be mentioned. Further, the commercially available near infrared absorbents SIR-103, SIR-114, SIR-128, SIR-130, SIR-132, SIR-152, SIR-159, SIR-162 (all made by Mitsui Toatsu Dyes), Kayasorb IR-750, Kayasorb IRG-002, Kayasorb IRG-003, IR-820B, Kayasorb IRG-022, Kayasorb IRG-023, Kayasorb CY-2, Kayasorb CY-4, Kayasorb CY-9 (all made by Nippon Kayaku), etc. may be mentioned.

[0055]

The dyes are not particularly limited so long as they are ones which uniformly disperse and dissolve in thermoplastic resins including an alicyclic structure, but broad use is made of oil-soluble dyes (various CI solvent dyes) since they are superior in solubility with the thermoplastic hydrocarbon-based polymers used in the present invention. As specific examples of oil-soluble dyes, the various types of CI solvent dyes described in Color Index, vol. 3 of the Society of Dyes and Colourists may be mentioned.

[0056]

As pigments, for example, Pigment Red 38 and other dianilide-based pigments; Pigment Red 48:2, Pigment Red 53, Pigment Red 57:1, and other azo lake-based pigments; Pigment  
5 Red 144, Pigment Red 166, Pigment Red 220, Pigment Red 221, Pigment Red 248, and other condensation azo-based pigments; Pigment Red 171, Pigment Red 175, Pigment Red 176, Pigment Red 185, Pigment Red 208, and other benzimidazolone-based pigments; Pigment Red 122 and other quinacridone-based  
10 pigments; Pigment Red 149, Pigment Red 178, Pigment Red 179, and other perillene-based pigments; and Pigment Red 177 and other anthraquinone-based pigments may be mentioned.

[0057]

When the light guide plate of the present invention  
15 requires coloring, both a dye and pigment can be used within the range of the object of the present invention and are not limited, but coloring by a dye is preferable in the case of a light guide plate where microoptical characteristics become a problem. Further, a UV absorbent sometimes appears yellow  
20 to red to the eye, while a near infrared absorbent sometimes appears black to the eye. Therefore, there is no need for strictly differentiating between these and dyes in use. Further, they may be used together.

[0058]

25 As the plasticizer, for example, tricresyl phosphate,

trixylyl phosphate, triphenyl phosphate, triethylphenyl phosphate, diphenylcresyl phosphate, monophenyldicresyl phosphate, diphenylmonoxilylenyl phosphate, monophenyldixilylenyl phosphate, tributyl phosphate, triethyl phosphate, and other phosphate triester-based plasticizers; 5 dimethyl phthalate, dibutyl phthalate, diheptyl phthalate, di-n-octyl phthalate, di-2-ethylhexyl phthalate, diisononyl phthalate, octyldecyl phthalate, butylbenzyl phthalate, and other phthalate ester-based plasticizers; butyl oleate, 10 glyceryl monooleate esters, and other fatty acid-basic acid ester-based plasticizers; divalent alcohol ester-based plasticizers; oxylate ester-based plasticizers; etc. may be used. Among these, phosphate triester-based plasticizers are preferable. Tricresyl phosphate and trixylyl phosphate are 15 particularly preferable.

[0059]

Further, as specific examples of the plasticizer, squalane ( $C_{30}H_{62}$ ,  $M_w = 422.8$ ), liquid paraffin (White Oil, ISO VG10, ISO VG15, ISO VG32, ISO VG68, ISO VG100, VG8, VG21, etc. 20 defined in JIS), polyisobutene, hydrated polybutadiene, hydrated polyisoprene, etc. may be mentioned. Among these, squalane, liquid paraffin, and polyisobutene are preferred.

[0060]

An organic or inorganic filler are not particularly 25 limited so long as they are ones generally used in the polymer

industry.

[0061]

As an organic filler, a normal organic polymer particle or cross-linked organic polymer particle may be used.

5 Specifically, for example, polyethylene, polypropylene, polymethyl-1-butene, poly4-methyl-1-pentene, poly1-butene and other polyolefin; polyvinyl chloride, polyvinylidene chloride, vinyl polyfluoride, vinylidene fluoride, polychloroprene, chlorinated rubber and other halogen  
10 containing vinyl polymers; polyarylate, polymethacrylate, polyacrylamide, polyacrylonitrile, acrylonitrile butadiene styrene copolymer, polyacrylonitrile, acrylonitrile styrene acrylic ester (co)polymer and other  $\alpha, \beta$ -unsaturated acid or a (co)polymer of a derivative thereof; polyvinyl alcohol,  
15 polyvinyl acetate, vinyl stearate, vinyl polybenzoate, vinyl polymaleic acid, polyvinylbutyral, polyarylpthalate, polyarylmelamine, ethylene vinyl acetate copolymer and other unsaturated alcohol and amine or acryl derivative thereof or a polymer of acetar; polyethylene oxide, or a polymer from  
20 bis glycidyl ether; polyphenylene oxide;

polycarbonate; polysulfone; polyurethane, and an urea resin; nylon 6, nylon 66, nylon 11, nylon 12 and other polyamide; polyethylene terephthalate, polybutylene terephthalate, poly 1,4-dimethylol cyclohexane  
25 terephthalate and other polyester; a polymer having a

cross-linked structure of phenol formaldehyde resin, melanin formaldehyde resin and other aldehyde and phenyl, urea or melanin; for example, cellulose acetate, cellulose propionate, cellulose ether and other natural polymer  
5 compounds; and other particles and cross-linked particles may be mentioned.

[0062]

As an inorganic filler, oxides, hydroxides, sulfides, nitrides, halides, carbonates, sulfates, acetates,  
10 phosphates, phosphates, organic carboxylates, silicates, titanates, borates, of elements in groups 1, 2, 4, 6, 7, 8 to 10, 11, 12, 13 and 14, hydrated compounds of these, complex compounds centered around these, and natural mineral particles having chemical compositions of these.  
15 Specifically, lithium fluoride, borax (sodium borate hydrate) and other group 1 element compounds; magnesium carbonate, magnesium phosphate, magnesium oxide, magnesium chloride, magnesium acetate, magnesium fluoride, magnesium titanate, magnesium silicate, magnesium silicate hydrate  
20 (talc), calcium carbonate, calcium phosphate, calcium phosphate, calcium sulfate, calcium acetate, calcium terephthalate, calcium hydrate, calcium silicate, calcium fluoride, calcium titanate, strontium titanate, barium carbonate, barium phosphate, barium sulfate, barium  
25 phosphate and other group 2 element compounds;

titanium dioxide (titania), titanium monoxide, titanium nitride, zirconium dioxide (zirconia), zirconium monoxide and other group 4 element compounds; molybdenum dioxide, molybdenum trioxide, molybdenum sulfate and other  
5 group 6 element compounds; manganese chloride, manganese acetate and other group 7 element compounds; cobalt chloride, cobalt acetate and other groups 8 to 10 element compounds; cuprous iodide and other group 11 element compounds; zinc oxide, zinc acetate and other group 12 element compounds;  
10 aluminum oxide (alumina), aluminum fluoride, almino silicate (alumina silicate, kaolin, kaolinate) and other group 13 element compounds; silica oxide (silica, silica gel), graphite, carbon, graphite, glass and other group 14 element compounds; carnalite, kainite, mica (mica, phlogopite)  
15 bilose and other natural mineral particles may be mentioned.

[0063]

In the present invention, it is particularly preferable to blend a turbidity inhibitor as a compounding agent, and those capable of preventing turbidity under a high  
20 temperature and high humidity environment without deteriorating characteristics of a thermoplastic resin containing an alicyclic structure, such as transparency, low hygroscopic property, heat resistance property and mechanical strength, are preferable. As a turbidity inhibitor,  
25 at least one kind of compound selected from a group of the

above soft polymers, the above organic or inorganic fillers, alcoholic compounds, and compounds not phase soluble with thermoplastic resin containing an alicyclic structures may be mentioned. Among these, alcoholic compounds and soft  
5 polymers are preferable and soft polymers are particularly preferable to attain transparency, heat resistance property, moldability and highly balanced turbidity inhibition under a high temperature and high humidity environment.

[0064]

10 In terms of preventing turbidity, a copolymer of an aromatic vinyl based monomer and conjugated diene based monomer and a hydrogenate thereof are preferable among the soft polymers for having excellent dispersibility with thermoplastic resin containing an alicyclic structures. A  
15 copolymer of an aromatic vinyl based monomer and conjugated diene based monomer may be a block copolymer or a random copolymer. In terms of heat resistance property, a hydrogenated copolymer wherein the rest of an aromatic ring is hydrogenated is more preferable. As an example of such a  
20 soft polymer, for example, a hydrogenates of homopolymer of polybutadiene, etc., a hydrogenate of a random copolymer of butadiene styrene copolymer, etc.; hydrogenates of a butadiene styrene block copolymer, styrene butadiene styrene block copolymer, isoprene styrene block copolymer, styrene  
25 isoprene styrene block copolymer and other block copolymers

may be mentioned.

[0065]

In the above organic or inorganic fillers, an average particle diameter is suitably selected in accordance with use  
5 object, and transparency and a turbidity prevention effect under a high temperature and high humidity environment are highly balanced when the average particle diameter of [(long diameter + short diameter)/2] is in a range of normally 0.01 to 50  $\mu\text{m}$ , preferably 0.1 to 30  $\mu\text{m}$ . Also, while not particularly  
10 limited, spherical particles having a ratio of lengths of a long side and a short side is 2 to 1 or less are preferable.

[0066]

As a preferable alcoholic compound as a turbidity inhibitor, compounds having at least one ether bond with at  
15 least one alcoholic hydroxyl group or compounds having at least one ester bond with at least one alcoholic hydroxyl group may be mentioned.

[0067]

A compound having at least one ether bond with at least  
20 one alcoholic hydroxyl group is not particularly limited as far as it is an organic compound having at least one alcoholic hydroxyl group, not a phenol hydroxyl group, and at least one ether bond unit in a molecule. For example, a partial ether compound wherein a part of a hydroxyl group of dihydric  
25 alcohol or furthermore preferably multiple alcohol having 3



to 8 hydroxyl groups is etherified may be mentioned.

[0068]

Also, a compound having at least one ester bond with at least one alcoholic hydroxyl group is not particularly limited as far as it is an organic compound having at least one alcoholic hydroxyl group, not a phenol hydroxyl group, and at least one ether bond unit in a molecule. For example, a partial ether compound wherein a part of a hydroxyl group of dihydric alcohol or furthermore preferably multiple alcohol having 3 to 8 hydroxyl groups is etherified may be mentioned. As a multiple alcohol of dihydric or more, for example, polyethylene glycol, glycerol, trimethylol propane, pentaerythritol, diglycerol, triglycerol, dipentaerythritol, 1,6,7-trihydroxy-2,2-di(hydroxymethyl)-4-oxy heptane, solbidol, 2-methyl-1,6,7-trihydroxy-2-hydroxymethyl-4-oxy heptane, 1,5,6-trihydroxy-3-oxohexane pentaerythritol, tris(2-hydroxyethyl)isocyanurate, etc. may be mentioned. Among these, multiple alcohol of trihydric or more and multiple alcohol having 3 to 8 hydroxyl groups are particularly preferable. Also, to obtain a partial ester compound, glycerol, diglycerol, and triglycerol, etc. capable of composing a partial ester compound including  $\alpha,\beta$ -diol are preferable.

25

[0069]

As such a partial ether compound or partial ester compound, specifically, for example, ester compounds of glycerin monostearate, glycerin monolaurate, glycerin monobehenate, diglycerin monostearate, glycerin distearate, 5 diglycerin monolaurate, pentaerythritol monostearate, pentaerythritol monolaurate, pentaerythritol behenate, pentaerythritol dilaurate, pentaerythritol tristearate, dipentaerythritol distearate, and other multiple alcohol, and corresponding ether compounds;

10 3-(octyloxy)-1,2-propanediol,  
 3-(lauryloxy)-1,2-propanediol,  
 3-(4-nonylphenyloxy)-1,2-propandiol,  
 1,6-dihydroxy-2,2-di(hydroxymethyl)-7-(4nonylphenyloxy)-4-  
 -oxoheptane, an ether compound obtained by reacting

15 p-nonylphenylether, condensed aldehyde and glycidol, and an ether compound obtained by reacting p-octylphenylether, condensed dicyclopentadiene and glycidol, etc. may be mentioned.

[0070]

20 Molecular weight of these alcoholic compounds is not particularly limited but normally 100 to 3000, preferably 200 to 2000, more preferably 300 to 1500. In that range, transparency and turbidity prevention effect are highly balanced and preferable

25 [0071]

A compound not phase-soluble with the above thermoplastic resin containing an alicyclic structure is a compound other than the above alcoholic compounds, fillers, and soft polymers and not phase-soluble with thermoplastic resin containing an alicyclic structures. The compound not phase-soluble with the above thermoplastic resin containing an alicyclic structure is not particularly limited as far as it is a non phase-soluble compound which does not completely dissolved in the above thermoplastic resin containing an alicyclic structure. Non phase-solubility is judged by following a normal method in the resin industries. For example, by observing a shaped article obtained by melting and mixing 5 parts by weight of a compound with respect to 100 parts by weight of a thermoplastic resin containing an alicyclic structure by magnifying 100000 times by an electron microscope, and those having at least one domain or particle of  $1\text{ mm}^2$  or more in a  $10\text{ cm} \times 15\text{ cm}$  range can be defined non phase-soluble. As a non phase-soluble compound, resins other than thermoplastic resin containing an alicyclic structures are normally used.

[0072]

As other resins not phase-soluble with thermoplastic resin containing an alicyclic structures, for example, polyphenylene sulfide, polyphenylene ether and other polyether or polythioether; aromatic polyester, polyarylate,

polyethylene terephthalate, polybutylene terephthalate, polycarbonate, polyether ketone and other polyester based polymers; polyethylene, polypropylene, poly 4-methyl-pentene-1 and other chain polyolefin based polymers; polymethyl methacrylate, a copolymer of cyclohexylmethacrylate and methylmethacrylate, polyacrylonitrile styrene (an AS resin) and other general purpose transparent resins; an acrylic resin; an MS resin; liquid crystal plastic, etc. may be mentioned.

10 [0073]

When adding a non phase-soluble compound to these thermoplastic resin containing an alicyclic structures, a large number of micro domains are formed in a shaped article in many cases. When forming micro domains, the average particle diameter  $[(\text{long diameter} + \text{short diameter})/2]$  of domains observed by an electron microscope is normally 0.001 to 0.5  $\mu\text{m}$ , preferably 0.005 to 0.3  $\mu\text{m}$ , particularly preferably 0.01 to 0.2  $\mu\text{m}$ . When the size is in the range, transparency and the turbidity prevention effect under a high temperature and high humidity environment are highly balanced and preferable.

[0074]

A refractive index of these turbidity inhibitors may be suitably selected in accordance with a use object, and the difference is normally 0.5 or less, preferably 0.2 or less,

more preferably 0.1 or less from the refractive index of a thermoplastic resin containing an alicyclic structure. When in the range, it is preferable because transparency and turbidity prevention effect under a high temperature and high humidity environment are highly balanced.

[0075]

These turbidity inhibitor may be used alone or in combination of two or more kinds. The blending ratio of the turbidity inhibitor may be suitably selected in a range of bringing out the turbidity prevention effect. It is normally 0.01 to 10 parts by weight, preferably 0.03 to 5 parts by weight, more preferably 0.05 to 2 parts by weight with respect to 100 parts by weight of a thermoplastic resin containing an alicyclic structure. When blending by the ratio in the range, heat resistance property, transparency and the turbidity prevention effect under a high temperature and high humidity environment are highly balanced and preferable.

[0076]

#### Shaped Article

In the present invention, the above thermoplastic resin containing an alicyclic structure alone or those blended with other resins, soft polymers, compounding agents explained above in accordance with need can be used as a molding material. The molding material is normally kneaded by using a twin screw kneader, extruded to be a stick shape in a molten state, cut

to a suitable length by a strand cutter and palletized to be used.

[0077]

Molding Method

5 In the present invention, a light guide plate can be obtained by performing melt molding on the above molding material. The melt molding method is not particularly limited and, for example, hot press molding and injection molding may be mentioned, and injection molding is preferable. When  
10 molding a light guide plate by using a thermoplastic resin containing an alicyclic structure having a certain amount or more of specific structure units and a specific range of MFR in the present invention, by applying injection molding particularly selected from melt molding methods, molding in  
15 a range of obtaining good plasticity and not causing molding defective becomes possible and cooling and curing of the shaped article becomes easy. Furthermore, a pattern of fine shapes, such as V-grooves, on the reflection surface side of the light guide plate can be transferred with high accuracy.  
20 Furthermore, since melting viscosity is low even when the resin temperature is lowered and fluidity can be secured, there are also effects that cycle time at the time of molding is relatively short, productivity of the shaped article is improved, the residence time in a molten state becomes short  
25 and the rate of occurrence of voids, burn marks, and

discoloration falls.

A molding condition is suitably selected in accordance with a use object and molding method and, for example, a resin temperature is suitably selected in a range of normally 150 to 400°C, preferably 180 to 360°C, more preferably 190 to 330°C, particularly preferably 200 to 300°C in an injection molding method. When the resin temperature is excessively low, fluidity deteriorates, whiskers and warps arise on a shaped article, while when the resin temperature is excessively high, silver streaks arise due to thermal decomposition of the resin, a shaped article becomes yellowish and other molding defectives may be caused.

[0078]

When performing injection molding, normally, the molding material is melted in a cylinder and injected into a mold. The resin temperature is set by a temperature of the cylinder at this time. Also, the molding material is normally put in a hopper and fed to the cylinder by a screw set to have a rotation rate for uniformly mixing the molding material.

[0079]

The injection rate from the cylinder to the mold is normally 10 to 1000 cm<sup>3</sup>/sec. In this range, it becomes possible to mold a light guide plate having a relatively large screen size (10 inches or more) with a high planar accuracy and preferable.

[0080]

An injection pressure from the cylinder to the mold may be suitably selected and set in consideration of design of the mold, fluidity of a thermoplastic resin containing an alicyclic structure to be used and other condition, and is  
5 normally in a range of 500 to 1500 kgf/cm<sup>2</sup>.

[0081]

The holding pressure is a pressure applied after filling the molding material in the mold from the cylinder  
10 with an injection pressure for a certain time until a gate part of the mold is completely cooled and cured. The upper limit of the holding pressure is set within the range of the clamping pressure of the mold and is not more than 2000 kgf/cm<sup>2</sup>, preferably not more than 1700 kgf/cm<sup>2</sup>, more preferably not  
15 more than 1500 kgf/cm<sup>2</sup>. By setting the upper limit of the holding pressure in this range, warps and other molding defectives are not caused on shaped articles. The lower limit is set to be in a range of at least 100 kgf/cm<sup>2</sup>, preferably at least 120 kgf/cm<sup>2</sup>, more preferably at least 150 kgf/cm<sup>2</sup>.  
20 By making the holding pressure within the range, the occurrence of whiskers at the light guide plate of the shaped article is prevented, the mold shrinkage factor can be made small, and a light guide plate superior in dimensional accuracy can be obtained.

25

[0082]



The mold temperature is normally set to be a lower temperature than a glass transition temperature ( $T_g$ ) of the thermoplastic resin containing an alicyclic structure, preferably lower by 0 to 100°C than the  $T_g$  of the thermoplastic resin containing an alicyclic structure, more preferably by 20 to 60°C than the  $T_g$ . By setting the mold temperature in the range, warps on the shaped articles can be suppressed.

[0083]

Also, on an object of reducing deterioration of colors and generation of carbide and voids of shaped articles as much as possible, the molding material as a molding resin is dried in advance in some cases. The drying condition is preferably to perform vacuum drying at the temperature of normally 50 to 200°C, preferably 80 to 150°C, more preferably 100 to 110°C, for normally 1 to 100 hours, preferably 2 to 50 hours, more preferably 4 to 12 hours, or to make nitride etc. flow from the hopper portion of the injection molding device to replacing with the air.

[0084]

## Light Guide Plate

Below, embodiment of a light guide plate molded as above will be explained. FIG. 1(A) is a schematic perspective view showing an outline of a planar light source device incorporating a light guide plate according to the present embodiment, FIG. 1(B) is a sectional view of FIG. 1(A), FIG.

1 (C) is an enlarged view of a key part of FIG. 1 (B) and FIG. 1 (D) is an enlarged view of a part of a reflection surface of FIG. 1 (C). First, an outline of a planar light source device, particularly, an edge light type planar light source device will be explained.

[0085]

For example, as shown in FIG. 1 (A), the edge light type planar light source device 10 is comprised of a light guide plate 100 for guiding and emitting light from a light source incident from a incidence face 100a in a longitudinal direction, a light source 200 comprised of a cold cathode tube etc. arranged at least at one side face of the light guide plate, a lamp reflector 300 arranged so as to surround the plate 100 the light of the light source which did not directly strike the incidence face 100a of the light guide plate 100, a light diffusion sheet 400 arranged at the emission face 100b of the light guide plate 100 for diffusing the light emitted from the emission face 100b, and a reflection sheet 500 arranged at the reflection face 100c side of the light guide plate 100 for returning the light leaking from the light guide plate 100 to the light guide plate 100 once again.

[0086]

As shown in FIG. 1 (B), the light guide plate 100 according to the present embodiment forms a wedge shape so

that the sectional shape becomes gradually thinner the further from the light source 200 so that light emitted from the emission face 100b becomes uniform as a whole. The further the sectional face is from the light source 200, the less the  
5 incident angle  $\theta_1$  (refer to FIG. 1(C)) with respect to an outside of the emission surface 100b of the light guide plate becomes than the critical angle (the minimum angle of bringing entire reflection).

[0087]

10 Note that the light guide plate in the present invention has a thickness of a face 100a based on the incidence face of not more than 5 mm, preferably 0.1 to 4 mm, more preferably 0.3 to 3 mm. A thickness of the opposed face 100d is not more  
15 than 4 mm, preferably 0.05 to 3 mm, more preferably 0.1 to 2 mm. Further, the ratio of area of the incidence face and the emission end face is, based on the former/latter, 1/5 to 1/500, preferably 1/10 to 1/400, more preferably 1/15 to 1/300. Further, greater effects can be expected in a light guide plate having a length of the diagonal of the emission face  
20 of normally 1 to 50 inches, preferably 5 to 40 inches, more preferably 10 to 30 inches, particularly preferably 14 to 25 inches.

[0088]

As shown in FIG. 1(C), in this embodiment, a mold which  
25 can give a light guide plate having on the back face of the

light guide plate 100 a pattern comprised of V-grooves 1001 in a gradually increasing density or deeper depth from the light source side of the light guide plate 100 to the end portion is used. The pitch  $P_c$  (see FIG. 1(D)) between  
5 adjoining V-grooves 1001 in the present embodiment is 10 to 5000  $\mu\text{m}$ , preferably 30 to 1000  $\mu\text{m}$ , more preferably 50 to 500  $\mu\text{m}$ . Further, the height  $H$  of the V-groove 1001 is 10 to 5000  $\mu\text{m}$ , preferably 30 to 1000  $\mu\text{m}$ , more preferably 50 to 500  $\mu\text{m}$ . Further, the pitch  $P_c$  at the nonincidence face 100d side of  
10 the light guide plate 100 between V-grooves 1001 is preferably 0.5 to 50% smaller than the pitch  $P_c$  at the incidence face 100a.

[0089]

Note that in the present invention, use of the "light  
15 guide plate" is not particularly limited and, for example, a light guide plate used in planar light source devices used as backlights for laptop type, notebook type, book type, palmtop type, and other type PCs, word processors, and other office automation apparatuses, wall hanging and other liquid  
20 crystal televisions and other household electrical appliances, decorative electrical signboards, light tables, viewers, and other display devices.

[0090]

[Examples]

25 Below, the present invention will be explained based

on further specified examples by comparing with comparative examples. The present invention however is not limited to these examples. Further, in the examples and comparative examples below, the "parts" and "%" are based on weight unless  
5 specifically stated otherwise. The methods of measuring the various physical properties in the following examples and comparative example are as follows.

[0091]

(1) The refractive index is a value measured based on  
10 ASTM-D542 at 25°C.

[0092]

(2) The hydrogenate rate was calculated by  $^1\text{H-NHR}$  measurement.

[0093]

15 (3) The glass transition temperature ( $T_g$ ) is a value measured based on JIS-K7121.

[0094]

(4) The melt flow rate (MFR) was measured based on JIS-K6719 with a load of 2.16 kgf at 280°C. Note that the  
20 diameter of a hole of the die was  $2.095 \pm 0.03$  mm, while the distance of movement of the piston was made  $25.0 \pm 0.25$  mm.

[0095]

(5) The "transparency" was measured by measuring the light transmittance (%) while continuously changing the  
25 wavelength in a range of 400 to 900 nm by a spectrophotometer

(Model U-30 made by Nippon Bunkosha) and defining the minimum transmittance as the light transmittance of the light guide plate. The higher the light transmittance, the better the transparency.

5 [0096]

(6) The front luminance was obtained by stacking a diffusion sheet (100MX made by Kimoto Co.) on the emission face side on a molded light guide plate, measuring luminance at nine points at equal intervals (in the vertical direction) with respect to the long sides and short sides on the light guide plate light emission face stacked with the sheet, and calculating an average value thereof.

[0097]

(7) The luminance unevenness was obtained by measuring the luminance at nine spots (vertical direction) at equal intervals with respect to the long sides and short sides of the face of the light guide plate (rectangular face 1.5 cm inside from the periphery of the face of the light guide plate) using a luminance meter (BM-7, made by Topcon Co.), calculating the luminance unevenness (%) by (minimum value/maximum value) x 100, and evaluating the results by the following judgment criteria: VG (very good): 88% or more

◎: 92% or more

○: 88% to less than 92%

25 △: 84% to less than 88%

X: less than 84%

[0098]

(8) The appearance and moldability was determined by checking if there are bubbles, voids, or other defects in the light guide plate obtained by sight or checking if the shapes of the V-grooves have been transferred well and evaluated by the following judgment criteria:

◎: good transfer of shapes of V-grooves without defectives

10 ○: No problem in molding in transfer of shapes of V-grooves

△: bubbles, voids, burrs, and other defects partially observed and gaps or short shots partially observed in transfer of V-grooves

15 ×: bubbles, voids, burrs, and other defects observed and gaps or short shots observed in transfer of V-grooves

[0099]

(9) The heat resistance was evaluated by measuring the dimensional changes due to changes in the environment (temperature changes). A light guide plate is normally used for a long time under irradiation by a light source, so dimensional changes due to temperature often become problems. Therefore, the dimensional change after holding a light guide plate in a gear oven at 100°C for 24 hours was measured as a representative characteristic and evaluated by the

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following judgment criteria:

◎: no dimensional changes (0%)

○: dimensional changes of 0% to 0.3%

△: dimensional changes of 0.3% to 1.0%

5      ×: dimensional changes of 1.0% or more

[0100]

(10) The mechanical strength was evaluated by the impact resistance by a drop test. A 3/4 inch radius missile-shaped weight (weight 100 g) was allowed to naturally drop from a height of 1 meter on the same positions of 10 prepared light guide plates. The occurrence of cracks or fractures was examined. The evaluation was conducted by the following judgment criteria:

◎: cracks or fractures in zero out of 10 samples

15      ○: cracks or fractures in one to three out of 10 samples

△: cracks or fractures in four to six out of 10 samples

×: cracks or fractures in seven or more out of 10 samples

[0101]

20      (11) The durability test under a high temperature and high humidity environment was conducted by allowing a sample to stand in a high temperature, high humidity tank of a humidity of 90% and temperature of 80°C for 1000 hours, rapidly taking it out into a room temperature environment

25      (outside a tester), then investigating the turbidity after



the elapse of several minutes (change in light transmittance). The light transmittance at 700 nm was measured by a visible UV spectrophotometer, the value of (light transmittance after test/light transmittance immediately after molding) x 100 was  
5 calculated, and an evaluation was conducted under the following judgment criteria.

◎: 98% or more (very good)

○: 96% to less than 98% (good)

△: 94% to less than 96% (fair)

10 ×: less than 94% (poor)

[0102]

[Production Example 1]

1.22 parts of 1-hexene diluted by 10 parts of cyclohexane, 0.11 part of dibutyl ether, and 0.22 part of  
15 triisobutylaluminum were placed into a reaction and mixed with 250 parts of dehydrated cyclohexane in a nitrogen atmosphere at room temperature, then 100 parts of tricycle[4,3,0,1<sup>2,5</sup>]deca-3,7-diene (hereinafter referred to as DCP) and 30 parts of a 0.70% toluene solution of tungsten  
20 hexachloride were continuously added over 2 hours while holding at 45°C for polymerization. The adjusted polymerization reaction solution was transported as it was to a pressure-resistant hydrogenation reactor, 10 parts of a diatomaceous earth-carrying nickel catalyst were added, and  
25 a reaction was caused at 180°C at a hydrogen pressure of 45

kgf/cm<sup>2</sup> for 10 hours. This solution was filtered by a filter provided with a stainless steel mesh using diatomaceous earth as a filtration aid to remove the catalyst. The obtained reaction solution was poured into 3000 parts of isopropyl alcohol with agitation to cause the precipitation of the hydrogenate. This was then recovered by filtration. Further, the filtrate was washed by 500 parts of acetone, then dried in a reduced pressure drier set to not more than 1 torr and 100°C for 48 hours to obtain 95 parts of a ring-opening polymer hydrogenate (A). The MFR of the obtained ring-opening polymer hydrogenate (A) was 54 [g/10min.], the ratio of the repeating units including an alicyclic structure in the total polymer repeating units was 100 mol%, the T<sub>g</sub> was 94°C, the refractive index was 1.53, the hydrogenation rate was 99.9%, the weight average molecular weight (M<sub>w</sub>) obtained from high pressure liquid chromatography (converted to polyisoprene) using cyclohexane as a transport layer was 31500, and the molecular weight distribution (M<sub>w</sub>/M<sub>n</sub>) was 2.10.

[0103]

[Production Method 2]

The same procedure was followed as in Production Example 1 other than making the amount of addition of 1-hexene to 1.08 parts by weight to obtain a ring-opening polymer hydrogenate (B). The MFR of the obtained ring-opening polymer hydrogenate (B) was 32 [g/10min.], the ratio of the repeating

units including an alicyclic structure in the total polymer repeating units was 100 mol%, the Tg was 94°C, the refractive index was 1.53, the hydrogenation rate was 99.9%, the weight average molecular weight (Mw) obtained from high pressure liquid chromatography (converted to polyisoprene) using cyclohexane as a mobile phase was 36000, and the molecular weight distribution (Mw/Mn) was 2.15.

[0104]

[Production Method 3]

The same procedure was followed as in Production Example 1 other than making the amount of addition of 1-hexene to 1.35 parts by weight to obtain a ring-opening polymer hydrogenate (C). The MFR of the obtained ring-opening polymer hydrogenate (C) was 185 [g/10min.], the ratio of the repeating units including an alicyclic structure in the total polymer repeating units was 100 mol%, the Tg was 93°C, the refractive index was 1.53, the hydrogenation rate was 99.9%, the weight average molecular weight (Mw) obtained from high pressure liquid chromatography (converted to polyisoprene) using cyclohexane as a transport layer was 19200, and the molecular weight distribution (Mw/Mn) was 2.08.

[0105]

[Production Method 4]

The same procedure was followed as in Production Example 1 other than making the amount of addition of 1-hexene

to 1.40 parts by weight to obtain a ring-opening polymer hydrogenate (D). The MFR of the obtained ring-opening polymer hydrogenate (C) was 259 [g/10min.], the ratio of the repeating units including an alicyclic structure in the total polymer repeating units was 100 mol%, the Tg was 93°C, the refractive index was 1.53, the hydrogenation rate was 99.9%, the weight average molecular weight (Mw) obtained from high pressure liquid chromatography (converted to polyisoprene) using cyclohexane as a transport layer was 13500, and the molecular weight distribution (Mw/Mn) was 2.05.

[0106]

#### Examples 1 to 4

0.2 part by weight of the phenol-based antioxidant pentaerythrityl-tetrakis(3-(3,5-di-t-butyl-4-hydroxyphenyl)propionate) and 0.4 part by weight of the hydrogenated styrene-butadiene-styrene block copolymer (Tuftec H1051 made by Asahi Kasei, crumbs, refractive index of 1.52 at 30°C) were mixed in 100 parts by weight of each of polymers A to D obtained in Production Examples 1 to 4 and kneaded by a twin-screw kneader, then the strands (strand shaped molten resin) were passed through a strand cutter to obtain a pellet-(granular) shaped molded material. These pellets were injection molded to prepare light guide plates A to D. The molding conditions of the injection molding were the use of an injection molding machine of Model IS450 made by Toshiba

Machinery, a mold temperature of 80°C, a cylinder temperature of (280°C in the Examples 1, 2 and 4, 290°C in the Example 3), a nozzle temperature of 260°C, an injection pressure of 1000 kgf/cm<sup>2</sup>, a holding pressure of 800 kgf/cm<sup>2</sup>, a mold clamping pressure of 1200 kgf/cm<sup>2</sup>, an injection speed (corresponding to screw speed of advance) of 40 cm<sup>3</sup>/s, a screw back pressure of 70 kgf/cm<sup>2</sup>, and a screw speed of 30 rpm. Further, the time from the start of filling into the mold to the end of filling was 1 second.

10 [0107]

Each of the obtained light guide plates A to D, as shown in FIG. 1 (A) and FIG. 1 (B), had a wedge shape having a thickness at the wide end (100a side) of 2.2 mm, a thickness of the narrow end side (100d side) of 0.5 mm, a length from the wide end to the narrow end side of 190 mm, a length along the axial direction of the linear light source of 250 mm, and a gradually decreasing thickness in the direction from the wide end side to the narrow end side (direction substantially perpendicular to the center axis of the linear light source). At the time of mold release, no short shots or burrs and no cracks in the shaped article were observed. The light reflection face side of the light guide plate is formed with V-grooves becoming gradually denser the further from the wide end side of the light guide plate to the narrow end side. Note that the V-grooves had an apical angle of 110°, a pitch near the light

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source of 0.3 to 1.5 mm, and a pitch near the narrow end of 0.03 to 0.06 mm. The depth of the groove was made a uniform one of about 80  $\mu$ m. The gate shown in FIG. 2 is positioned at the side close to the light incident face from the substantial center portion of the side of the emission face. The gate length was 50 mm and the gate thickness 1.9 mm.

[0108]

Further, the existence of bubbles on the surface of the light guide plate was checked by sight, whereupon it was found that there were no bubbles on the surface and the appearance was excellent. Further, the total light transmittance of the light guide plate was measured. The result was that the transparency was excellent in all cases. Further, the mechanical strength was evaluated using each light guide plate, whereupon it was confirmed that the impact resistance was excellent. The heat resistance of each light guide plate obtained was also excellent. Further, the results of the durability test of the obtained light guide plate under a high temperature, high humidity environment were also excellent.

[0109]

A reflection tape of Model RF188 made by Tsujimoto Denki Seisakusho was adhered to the side end face of the light guide plate obtained in this way other than the light incident face. A cold cathode tube of a tube diameter of 2.4 mm made by Harrison Electric was placed at the short side light incident

end. The area around the tube and the light guide plate incidence part was covered by a reflector of Model GR38W made by Kimoto Co. Further, a light diffusion sheet of Model 100MX made by Kimoto Co. was placed at the emission face of the light guide plate, while a reflection sheet of Model RF188 made by Tsujimoto Denki Seisakusho was placed at the reflection face of the light guide plate to prepare an edge light type planar light source unit. This unit was used to evaluate the total light transmittance, luminance unevenness, and heat resistance. The results are summarized in Table 1.

[0110]

#### Example 5

Addition polymerization of 5-ethyl-bicyclo[2.2.1]-hept-2-ene and ethylene was performed by a well known method. The obtained addition polymer (E) had the MFR of 52 [g/10min.], the NB containing amount calculated by  $^{13}\text{C}$ -NMR was 60% (the ratio of repeating units having alicyclic structure in all polymer repeating units was 60 mol%), the Tg of 165°C, the refractive index of 1.52, the weight average molecular weight (Mw) of the polymer obtained from high pressure liquid chromatography (converted to polyisoprene) using cyclohexane as a mobile phase was 52000, and the molecular weight distribution (Mw/Mn) was 2.44. The resin was molded under the same molding condition as that in the example 1 to obtain a wedge shaped light guide plate having

V-grooves.

[0111]

The existence of bubbles on the surface of the light guide plate was checked by sight, whereupon it was found that there were no bubbles on the surface and the appearance was excellent. Further, the total light transmittance of the light guide plate was measured. The result was that the transparency was excellent in all cases. Further, the mechanical strength was evaluated using each light guide plate, whereupon it was confirmed that the impact resistance was excellent. The heat resistance of each light guide plate obtained was also excellent. Further, the results of the durability test of the obtained light guide plate under a high temperature, high humidity environment were also excellent. The result of evaluating the front luminance and luminance unevenness by using the same planar light source as that in the Example 1 is also shown with the above results in Table 1.

[0112]

20      Comparative Example 1

The same procedure was followed as in Production Example 1 other than making the amount of addition of 1-hexene to 0.84 part by weight to obtain a ring-opening polymer hydrogenate (F). The MFR of the obtained ring-opening polymer hydrogenate (F) was 15 [g/10min.], the ratio of the repeating



units including an alicyclic structure in the total polymer repeating units was 100 mol%, the T<sub>g</sub> was 95°C, the refractive index was 1.53, the hydrogenation rate was 99.9%, the weight average molecular weight (M<sub>w</sub>) obtained from high pressure liquid chromatography (converted to polyisoprene) using cyclohexane as a mobile phase was 42000, and the molecular weight distribution (M<sub>w</sub>/M<sub>n</sub>) was 2.20. This resin was molded under the same molding conditions as in Example 1 other than making the cylinder temperature 290°C to obtain a wedge-shaped light guide plate having V-grooves.

[0113]

The obtained light guide plate was free of short shots at the thin-walled part of the wedge shape, but transfer defects of the V-grooves were observed. The mechanical strength, heat resistance, and durability under a high temperature and high humidity environment of the light guide plate were all extremely good, but the transparency fell. Further, when evaluating the front luminance and luminance unevenness using a planar light source unit the same as Example 1, luminance unevenness occurred and the front luminance also fell. Note that whether there were bubbles in the surface of the light guide plate was checked by sight, whereupon it was found that there were bubbles in the surface. The results are shown in Table 1.

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[0114]

Comparative Example 2

The same procedure was followed as in Production Example 1 other than making the amount of addition of 1-hexene to 1.43 parts by weight to obtain a ring-opening polymer hydrogenate (G). The MFR of the obtained ring-opening polymer hydrogenate (G) was 321 [g/10min.], the ratio of the repeating units including an alicyclic structure in the total polymer repeating units was 100 mol%, the Tg was 94°C, the refractive index was 1.53, the hydrogenation rate was 99.9%, the weight average molecular weight (Mw) obtained from high pressure liquid chromatography (converted to polyisoprene) using cyclohexane as a mobile phase was 11500, and the molecular weight distribution (Mw/Mn) was 2.03. This resin was molded under the same molding conditions as in Example 1 to obtain a wedge-shaped light guide plate having V-grooves.

[0115]

The obtained light guide plate had preferable transparency, heat resistance and good evaluation on the durability test under high temperature and high humidity environment. But burrs occurred on the mold, cracks arose when releasing the shaped article from the mold, and the mechanical strength was inferior compared with that of the Examples. The front luminance and luminance unevenness were evaluated by using a planar light source unit the same as Example 1. Note that whether there were bubbles in the surface of the light

guide plate was checked by sight, and there were no bubbles on the surface. The results are shown in Table 1.

[0116]

Comparative Example 3

5        Addition polymer (H) of  
5-ethyl-bicyclo[2.2.1]-hept-2-ene and ethylene was obtained in the same way as in the example 5. The obtained addition polymer (H) had the MFR of 50 [g/10min.], the NB containing amount calculated by  $^{13}\text{C}$ -NMR was 40% (the ratio of repeating  
10 units having alicyclic structure in all polymer repeating units was 40 mol%), the Tg of 95°C, the refractive index of 1.52, the weight average molecular weight (Mw) of the polymer obtained from high pressure liquid chromatography (converted to polyisoprene) using cyclohexane as a mobile phase was 50500,  
15 and the molecular weight distribution (Mw/Mn) was 2.51. The resin was molded under the same molding condition as that in the example 1 to obtain a wedge shaped light guide plate having V-grooves.

[0117]

20        The obtained light guide plate had preferable appearance in moldability, evaluation on the durability test under a high temperature and high humidity environment was good, and transfer of V-grooves was preferable. But the mechanical strength was very low, the heat resistance was poor  
25 and transparency declined. When evaluating the front

luminance and luminance unevenness by using a planar light source unit the same as Example 1, evaluation on the luminance unevenness was good but the front luminance was declined. Note that whether there were bubbles in the surface of the light guide plate was checked by sight, and there were no bubbles on the surface. The results are shown in Table 1.

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[0118]

[Table 1]

	Polymer	MFR [g/10min. J	Ratio of Alicyclic Structure Unit mol%	Glass Transition Temperature °C	Entire Light Transmittanc e %	Front Luminance cd/cm <sup>2</sup>	Luminance Unevenness	Appearance Moldability	Heat Resistance	Mechanical Strength	High Temperature High Humidity
Example 1	Ring-Opening Hydrogenate A	54	100	94	92	1800	◎	◎	◎	◎	◎
Example 2	Ring-Opening Hydrogenate B	32	100	94	92	1450	○	○	◎	◎	◎
Example 3	Ring-Opening Hydrogenate C	185	100	93	92	1860	◎	◎	◎	◎	◎
Example 4	Ring-Opening Hydrogenate D	259	100	93	92	1900	◎	○	◎	○	◎
Example 5	Ring-Opening Hydrogenate E	52	60	165	92	1600	○	○	○	○	○
Comparative Example 1	Ring-Opening Hydrogenate F	15	100	95	91	1300	△	x bubbles	◎	◎	◎
Comparative Example 2	Ring-Opening Hydrogenate G	321	100	94	92	1850	○	x cracks	○	x	○
Comparative Example 3	Ring-Opening Hydrogenate H	50	40	95	91	1300	○	○	△	x	○

[0119]

[Effect of the Invention]

As explained above, in the present invention, since a specific thermoplastic resin containing an alicyclic  
5 structure is used, a light guide plate having good appearance, high luminance reduced luminance unevenness and excellent mechanical strength can be provided.

[0120]

Also, according to the present invention, a light guide  
10 plate having high front luminance, reduced luminance unevenness and excellent strength can be easily produced.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[FIG. 1] FIG. 1(A) is a schematic perspective view showing an outline of a planar light source device  
15 incorporating a light guide plate according to the present embodiment, FIG. 1(B) is a sectional view of FIG. 1(A), FIG. 1(C) is an enlarged view of a key part of FIG. 1(B), and FIG. 1(D) is an enlarged view of a part of a reflection face in FIG. 1(C).

20 [FIG. 2] FIG. 2(A) is a sectional view of a light guide plate according to the present embodiment, FIG. 2(B) is a view from the bottom of FIG. 2(A).

[Explanation of References]

10: planar light source device

25 100: light guide plate

100a: light incidence face

1001: V-grooves

100b: light emission face

100c: light reflection face

5 100d: end portion light reflection face

200: light source

300: lamp reflector

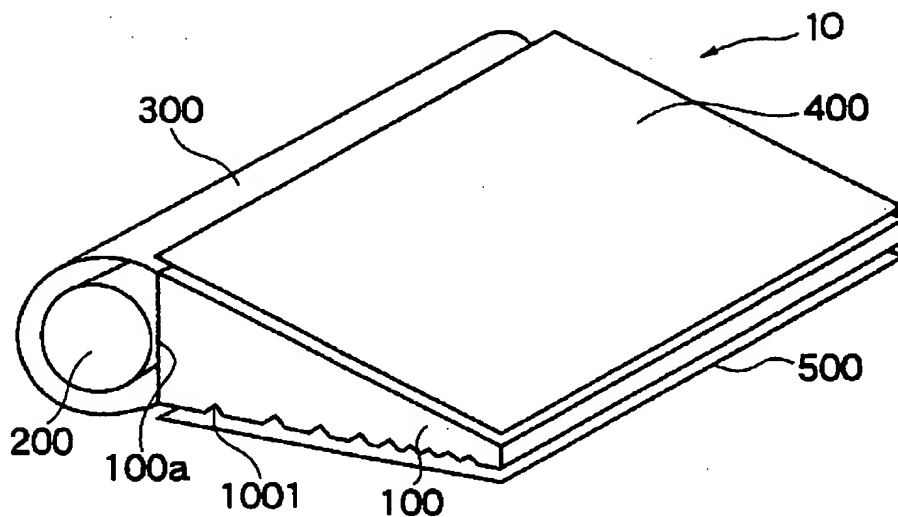
400: light diffusion sheet

500: light reflection sheet

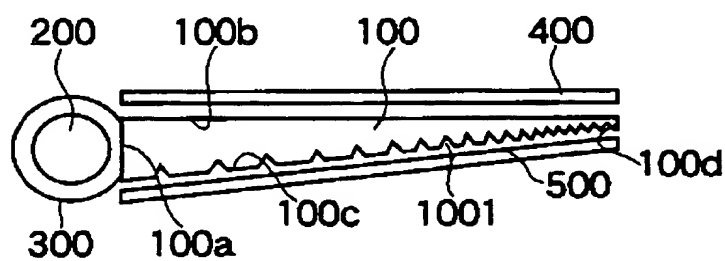
10 600: gate marks

# FIG.1

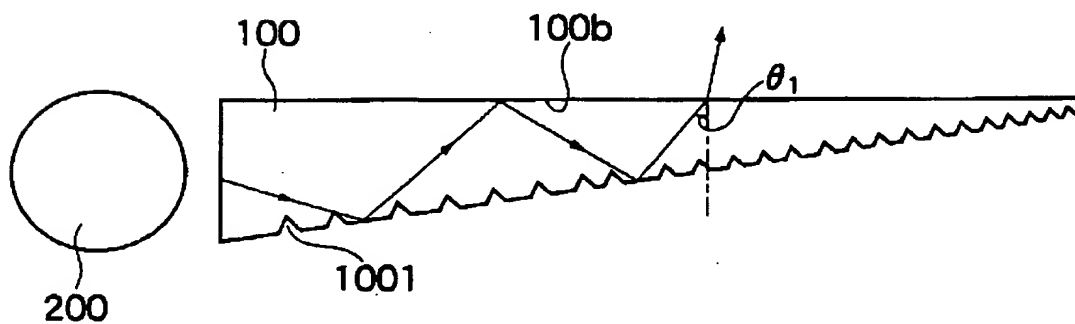
(A)



(B)



(C)



(D)

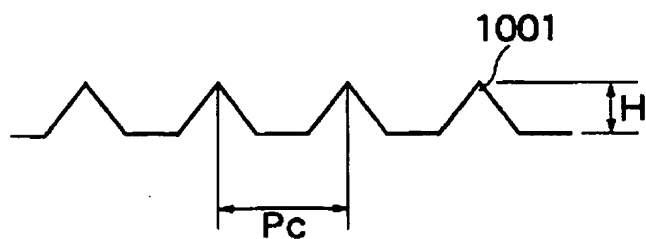
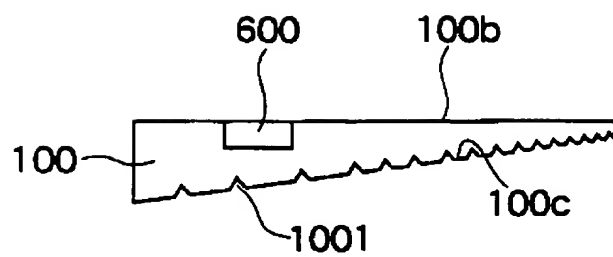


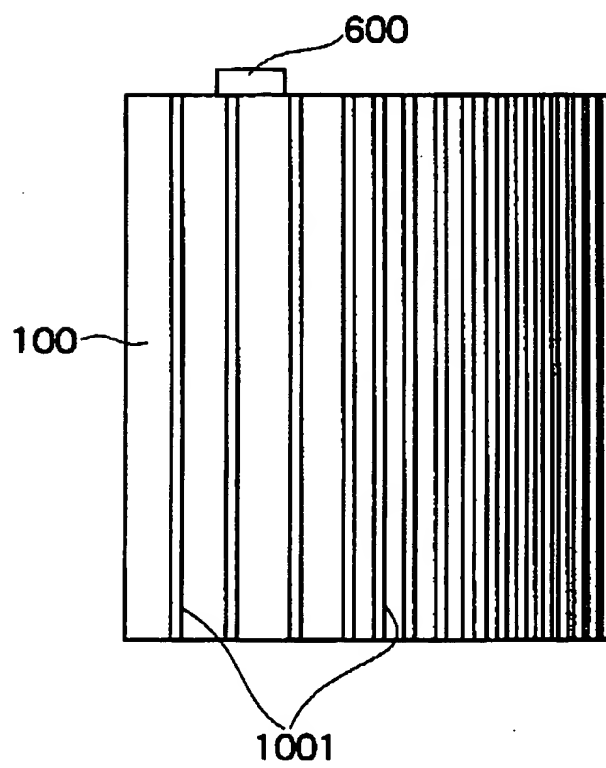


FIG.2

(A)



(B)



[DOCUMENT NAME] Abstract

[ABSTRACT]

[Problems] To provide a light guide plate having good appearance, high luminance, reduced luminance unevenness and  
5 excellent mechanical strength, and a production method of the same.

[Means for Solution] The light guide plate is comprised of a thermoplastic resin containing an alicyclic structure wherein a ratio of a repeating unit having alicyclic structure  
10 at its main chain and side chains in all repeating units in a polymer is 50 to 100 mol%, and the melt flow rate measured at 280°C with a load of 2.16 kgf based on JIS-K-6719 is 20 to 300 g/10min. The thermoplastic resin containing an alicyclic structure is preferably hydrogenate of a norbornene  
15 based ring-opening polymer.

[Selected Figure] FIG. 1